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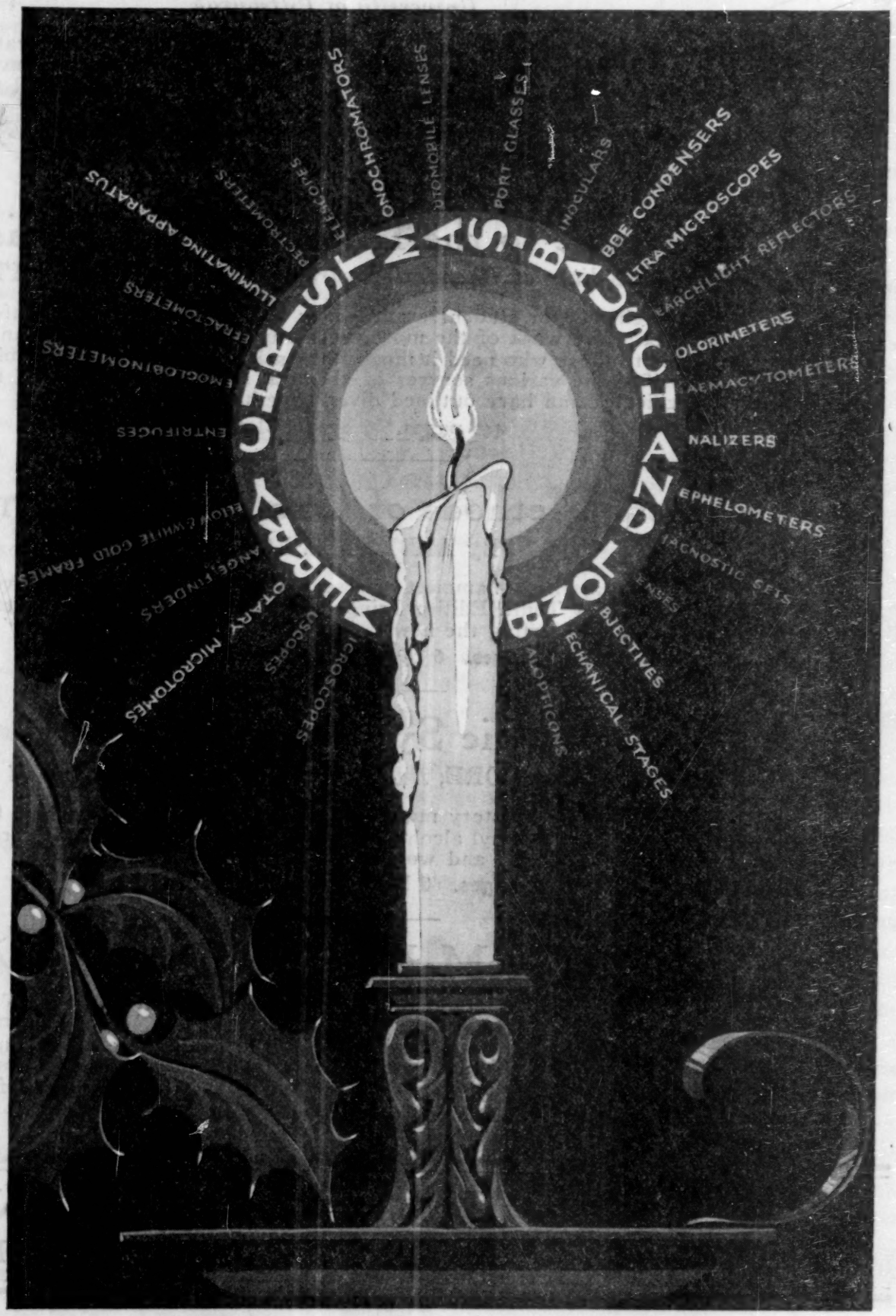

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THE STATE ACADEMIES OF SCIENCE AFFILIATED WITH THE AMERICAN ASSOCIATION[1]

SINCE the New Hampshire Academy of Science is now affiliated with the American Association for the Advancement of Science and is advancing shoulder to shoulder with twenty other affiliated state academies, it seems worth while to learn what these other organizations have accomplished and in what activities they are at present engaged. This address presents some of the results of a study of those questions.

Brief statements concerning the organization and work of sixteen of the affiliated academies were published in the last volume of "Summarized Proceedings of the American Association" (1921–1925), which appeared in December, 1925. Since that time five additional academies have become affiliated with the association.[2] In preparation for the study here reported, a questionnaire of eighteen specific questions was sent to the secretaries of all the academies in this group, excepting our own, and all but two of the twenty secretaries responded, some of them sending additional information about their academies. That the secretaries were keenly interested in the study is shown by the receipt of many publications from fourteen academies. Several of the secretaries expressed a desire to receive the results of the detailed study of the material collected.

Academies affiliated with the American Association exist in the following states: Alabama, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Nebraska, New Hampshire, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania,[2] Tennessee, Virginia, West Virginia, and Wisconsin. Reference to the map shows that these states form a group extending from the Atlantic Ocean to the Mississippi River, with an arm extending from Iowa through Nebraska and Kansas to Oklahoma. The region south and west of the last named states has no affiliated academies at present, partly because it is covered by the Pacific Division and the Southwestern Division of the American Asso-

[1] From the address of the retiring president of the New Hampshire Academy of Science, delivered at Waterville, N. H., June 4, 1927.

[2] A sixth additional academy (of South Carolina) became affiliated October 17, 1927. There are twenty-two in all.

ciation.[3] Some of the states in the regions of these two divisions have unaffiliated academies, as is also true with several other states outside of the regions of the divisions.

Of the twenty-one academies to be studied, sixteen have as their titles the name of the state followed by the words Academy of Science. These apparently take *science* to cover most of the field of classified knowledge and orderly thinking. Three use the phrase Academy of Sciences, thinking apparently of the cooperation and coordination of the separate fields into which science is too often or too definitely split up; these three academies are those of Maryland, Nebraska, and Louisiana, the last-named of which takes the name of the New Orleans Academy of Sciences. The two remaining academies add two other fields of intellectual effort. They are the Michgan Academy of Science, Arts and Letters, and the Wisconsin Academy of Sciences, Arts and Letters.

The New Orleans Academy is the oldest of the twenty-one present organizations, having been formed in 1853, and the Alabama Academy is the youngest, formed in 1924. There seem to have been three active periods of academy formation; three academies were formed in 1866–1870, five in 1885–1894, and eleven in 1902–1924. There seem to have been obvious though slightly less well defined active periods of academy formation in the years following the civil war and directly after the world war. Historians may see some significance in this last observation. The Iowa Academy of Science was organized in 1887, though it succeeded the Iowa Academy of Sciences which lived from 1875–1880. The Maryland Academy of Sciences was reorganized in 1866, as the successor of the Maryland Academy of Science and Literature, which was itself a reorganization in 1819 of the Academic Society, formed in 1797. To the Maryland Academy belongs the credit of being the pioneer in this field.

In this connection it should be mentioned that the formation of the New Hampshire Academy of Science in 1919 occurred at the suggestion of Dr. J. McKeen Cattell, editor of SCIENCE, the initial steps in the actual organization having been taken by a committee consisting of Professor John H. Gerould, Professor Norman E. Gilbert, and Dr. John M. Gile, of Hanover, with the cooperation of Professor W. C. O'Kane, Dr. Charles James, and Mr. H. L. Howes, of Durham. This was the outcome of a plan of the American Association to cooperate with the state academies of science and to encourage their foundation in states where they did not already exist. Dr. Cattell was one of the leaders in bringing about the arrangements for the official affiliation of state academies with the American Association, arrangements that began to operate in 1918.[4]

The number of members enrolled varies from fifty for New Orleans to about eight hundred for Maryland and for Indiana. The small size of the first-named academy is doubtless due to its being largely local and limited to research workers. The number of members apparently bears no relation to the age of an academy; it may depend on the population of the state, on entrance requirements or some other factor. It should be noticed, however, that the three academies having the largest enrolment include non-resident members.

The classification of members seems to be governed by no general principle; in fact, there is much confusion here. There are three academies (Alabama, Georgia, and New Orleans) with only one kind of members (active members), and there is one (Maryland) with six kinds (corresponding, associate and corporate members, fellows, patrons and founders). Examination of the complete list reveals these additional kinds: local, national, life, non-resident, annual, honorary and regular members, honorary fellows and life fellows. New Hampshire stands alone in having only two kinds, active and honorary members, with Michigan a close second, adding life members to the two kinds we have. Four academies have national members, meaning persons who are also members of the American Association for the Advancement of Science. All the academies have members with the standing of our own active members, though they are sometimes designated by different names. Thirteen have less than five kinds of members. Two have six kinds. Confusion is greatest in those cases where a member may belong to two different classifications; *e.g.*, the Oklahoma Academy has active members and fellows, and each of these may be either local or national; it also has honorary members. Seven of the academies list non-resident members, usually former active members who have moved from the state. Twelve academies have honorary members, or members of similar standing. The limitations to this honor are interesting. For New Hampshire the number is limited to ten, with a total enrolment of

[3] The Pacific Division now includes all members of the association residing in Alaska, British Columbia, Washington, Oregon, California, Idaho, Nevada, Utah, Mexico (excepting Sonora and Chihuahua), the Hawaiian and the Philippine Islands and other islands of the Pacific. The Southwestern Division now includes all members residing in Arizona, New Mexico, Colorado, Sonora, Chihuahua and Texas west of the Pecos River.

[4] For a list of the first academies to be affiliated and the dates of their affiliation, see SCIENCE for June 17, 1921.

131; for Kentucky the number is twenty, with an enrolment of 170, and for Ohio it is only twenty-five, with a total of 475. The other academies have, according to their constitutions, placed no limits on the number of honorary members. It is surprising that two (Kentucky and Ohio) confer this honor only on non-resident members; formerly the Nebraska Academy had a similar rule but rescinded the non-resident condition in 1920. Two academies (Michigan and Wisconsin) confer honorary membership for distinguished or conspicuous service in science, arts or letters, while one (Tennessee) confers this honor on "any white person who has attained prominence in any department of science."

The classification of members has apparently been established to meet local needs in each case. The multiplicity of names seems unfortunate, particularly as different names are sometimes used by different academies to designate the same kind of members. Simplification of nomenclature seems desirable and should make easier that correspondence between affiliated academies which is appearing so promisingly on the horizon, in connection with official affiliation with the American Association. It is suggested that the affiliated academies might, in cooperation with the American Association, bring classification of membership and the nomenclature thereof into closer agreement.

The payment of $20 in one academy (Illinois), $25 in two (Michigan and Nebraska) and $50 in one (Virginia) entitles a person to life membership. The payment of $100 in four academies (Indiana, Nebraska, North Carolina and Ohio) entitles a person to the standing of patron; the Virginia Academy, however, requires $1,000 for this form of membership.

Qualifications for membership may be covered generally by the statement that in fourteen of the academies any one "interested in science," "interested in the progress of science," or "interested in scientific work," to quote from the constitutions, may become an active member. The New Hampshire Academy is the only one that attaches an age limit (twenty-five years). Unless the committees on membership scrutinize applications very carefully, it seems to be rather easy to get into most of the academies. A few have more definite requirements; *e.g.,* Georgia requires five years of recognized scientific work or five years of productive work in a college faculty, or some noteworthy contribution to science; Illinois demands interest in science in the state and in the nation; for Indiana the candidate must be engaged in original research or some other phase of scientific work; New Hampshire wants proficiency in some branch of recognized science; North Carolina wants active interest in the promotion of science, while for Oklahoma, Pennsylvania and Tennessee the candidate should preferably be engaged in scientific work. Maryland again stands out in requiring, in addition to an interest in science, a desire for self-improvement and a desire to help others; this may be related to the fact that the Maryland Academy is "principally a popular academy in which any intelligent person of good character may participate." Curiously, two academies (New Orleans and Wisconsin) report that no qualifications are required for active membership. On the whole, qualifications seem to be framed broadly enough so that acquaintance with scientific workers in other fields than one's own may be obtained in a social and appreciative way without too much detailed machinery of enrolling. The experience of some academies in regard to membership qualification may well be useful to other academies and it might be very valuable if these qualifications might receive special attention from the Committee on Academy Relations, recently established by the American Association (SCIENCE for May 20, 1927, page 508, paragraph 14).

Annual dues are very moderate in all these academies, one dollar in eight academies and two dollars in four. Four academies require an initiation fee of one dollar, four require a two-dollar fee, and one a three-dollar fee. Annual dues of one or two dollars seem much more desirable than higher dues. Academy publications might better be financed in other ways than by means of annual dues, as will appear later in this paper.

In order to evaluate the objects or purposes of the state academies, each secretary was asked if the main object of his academy was "(1) to promote scientific research among purely scientific investigators of your state, or (2) to increase the fellowship among persons having scientific interests though not necessarily engaged in research." Dr. A. M. Peter, secretary of the Kentucky Academy, sent this reply: "The constitution of the Kentucky Academy declares that the object of the academy is 'to encourage scientific research, to promote the diffusion of useful scientific knowledge, and to unify the scientific interests of the State.' I think, however, that most good comes from bringing together those who are interested in scientific matters in the state, whether they are actually doing research work or not—that is, I think the most important duty of the academy is that described in your second item." This expresses very happily exactly what I think we all feel our own New Hampshire Academy stands for. It also expresses substantially what the majority of the secretaries express in varying ways. Two academies (Kansas and New Orleans) rate fostering research as more important than increasing fellowship; two others (Pennsylvania

and Tennessee) rate the two objects in the reverse order, and one (Iowa) rates the two about equally. Other comments of the secretaries are: The Indiana Academy maintains a research committee to receive requests for solutions of definite problems for the people of the state, and to assign them to proper experts for solution. The Maryland Academy seeks to be a popular center for all interested in natural science. The Michigan and Wisconsin Academies include also arts and letters. The New Orleans Academy emphasizes pure research almost exclusively. The North Carolina Academy finds that most of the actual work of the academy is done by the investigators. The secretary of the Virginia Academy, Dr. E. C. L. Miller, says: "Ours is a young society and the work so far has been mostly to build up the society and to promote fellowship among the scientists and good will toward science in the state. Now we have a permanent committee on research and are raising an endowment fund for this committee."

An examination of the academy constitutions gives additional support to the statement that Dr. Peter's reply, quoted above, is of general application. Indiana adds this object: "to assist by investigation and discussion in developing and making known the material, educational and other resources and riches of the state; to arrange and prepare for publication such reports of investigations and discussions as may further the aims and objects of the academy." Tennessee includes exactly these words and Oklahoma includes an abridged form of the same statement. North Carolina hopes "to furnish, so far as practicable, a means of publication of such articles as may be claimed worthy." Wisconsin says: "Among the special objects shall be the publication of the results of investigation and the formation of a library." Maryland supports a museum and maintains meeting rooms. Virginia lists as her fourth and fifth purposes: "to cooperate with other scientific bodies having similar aims and to render public service in scientific matters."

If the worth-whileness of any state academy of science is ever questioned, this enumeration of objects and purposes should certainly justify the existence of the organization. It should encourage us in renewed loyalty to and support of our own New Hampshire Academy and should make us proud that we are affiliated with such forward-looking scientific organizations. One secretary writes: "If your research discloses a very good reason for the existence of state academies of science I want to know it in order that we may get into the right line." He considers that the reading of scientific papers does not seem to him very important, but may be only a good excuse for getting the members together and giving them a chance to find out that the others are interested in what each one is doing. He then adds this significant suggestion: "I think the academy should have some hobby but I do not know what it ought to be."

As to the number of meetings per year, the academies are in close accord. Fifteen have but one meeting a year while three have two meetings. Two academies (Georgia and Oklahoma) specify that there may be extra meetings at the call of the council. Eighteen academies meet for the reading of papers and most of these mention transaction of business as one of the features. In the case of those that do not specifically mention business it is not clear just how it is transacted. Business may be delegated to a council or similar body. In several cases, including our own New Hampshire Academy, the council is instructed to transact business that arises between the annual meetings.

It is of interest that three secretaries specifically mention discussion as a regular part of the program; perhaps it should be inferred that other academies include this helpful and attractive feature without mentioning it. It may be that some academies are losing out to some extent by not stressing this feature. Four include regularly a lecture by a person of note, usually from another state. Opportunity for social intercourse is mentioned several times; luncheons, banquets, social gatherings, etc., occur in the programs. It appears that in most of the academies much is made of the encouragement of better acquaintance among the members. On the whole then the character of the meetings is pretty uniform.

Marked variations are: in one academy (Virginia) the program is stated to be made up of "papers mostly," and in two others (New Orleans and Wisconsin) of "papers only." Nebraska lists "Demonstrations" as part of the program. Experimental demonstrations or exhibitions of material might enliven considerably papers that would otherwise be less interesting and they might well be used much more than seems to be the case. Experience at various chemistry meetings has shown the markedly increased "selling value" of a paper that is thus accompanied by exhibit or experiment. An Ohio program lists nine exhibits relating to botany and zoology, and speaks of their not being as numerous as in the preceding year.

Eleven academies make field meetings part of the regular program. Two (Indiana and Oklahoma) devote the spring meeting entirely to inspecting industrial plants, visiting regions of geological or biological interest, etc., the reading of papers being reserved for the winter meeting. Most of the others combine field trips, as do we, with the regular pro-

gram of papers at the annual meeting. The Illinois Academy specifies that its field trips are designed "to stimulate interest in local flora, fauna, geology and industries."

It now becomes my sad duty to report that eight of the academies go on record as having no field trips, and examination of the literature received does not indicate that they employ such trips even "only incidentally," as one of the eleven mentioned above puts it. To those of us who have so keenly enjoyed our own field trips it must seem that those eight academies are omitting one of the most effective agencies to increase mutual acquaintance and to learn to see things through the other fellow's eyes.

In my enthusiasm for the field trips I almost forgot to say that the Maryland Academy of Sciences meets "every night," according to the blank returned from Baltimore. Probably this means every night but Sunday. The subjects taken up are varied. The members are "taken to the field under competent instructors for the purpose of investigation or study." It should be recalled that the Maryland Academy is organized definitely as an institution for public education in science, being thus different from any of the other academies studied.

The membership of the Georgia Academy is divided into eleven groups according to the subject in which each member is most interested. Similarly, Nebraska has eight groups. Programs are correspondingly divided. In an organization the size of ours here in New Hampshire such subdivision of the program would be entirely out of place and would defeat the main purpose of our coming together. In larger organizations, with large numbers in attendance, such subdivision may be advisable or even necessary.

As to the papers and addresses themselves, our own New Hampshire Academy may serve as an example. In the past seven years 106 papers have been presented, of which 15 were presidential addresses or formal lectures. This makes an average of 15 papers per meeting. The smallest number was eight, in our first year, and the largest was twenty-one, in 1923. When we remember that between supper Friday night and bed-time Saturday night there are available two evening sessions and two half-day sessions, we see how the number of papers may vary from year to year. One year there was no presidential address or formal lecture and the next year there were four papers of that kind. When Saturday afternoon was devoted to an inspection trip through an industrial plant or a college the number of papers was naturally smaller.

A hasty skimming of such programs, abstracts of papers and reports of meetings as are at hand indicates that the papers presented before other state academies do not differ markedly in number or character from those given at the New Hampshire meetings. In a few cases the papers have more direct bearing on the problems and progress of the state in which the academy is located. In some cases the papers seem generally to be the result of considerable scientific investigation, the kind of papers published in the special scientific journals. Such more technical papers may be more appropriate for some of the larger academies than for the smaller ones. For us, however, this might be taken as suggesting a possible bettering of our own programs, or at least as a hint that we should not neglect our service to our state in the midst of our personal scientific enjoyment.

Of great interest to those making up academy programs and those presiding at the meetings is that several of the programs examined show a time limit after the title of each paper. This device has proved so satisfactory in other organizations that it might perhaps be more generally adopted by the state academies. The most extreme case noted was a program that limited all papers to ten minutes each.

It may be of interest to list here a few titles of presidential addresses selected from the academy reports at hand. Some presidents deal with the special subjects in which they are directly interested, while others deal with broader and more general aspects of science. Of course the president should try to feel the pulse of his academy and to point the way to a larger vision. The titles selected are as follows:

Bacteriology and its practical significance (C. A. Belvrem, Indiana).

Flora of Indiana: On the distribution of the ferns, fern allies and flowering plants (C. C. Dean, Indiana).

The unselfish service of science (W. M. Blandard, Indiana).

Biological laws and social progress (H. L. Bruner, Indiana).

The earth's framework (E. R. Cumings, Indiana).

The social responsibility of science (O. H. Smith, Iowa).

Geology of some proposed Kentucky State parks (W. R. Jillson, Kentucky).

The effect of the teaching of evolution upon the religious convictions of undergraduate students, as evidenced by theses upon this subject (A. R. Middleton, Kentucky).

Science and letters (C. Bamer, Michigan).

American botany during the colonial period (H. H. Bartlett, Michigan).

Recent research in atomic structure (J. C. Jensen, Nebraska).

Accumulation of energy by plants (E. N. Transeau, Ohio).

Research in industry (J. H. Cloud, Oklahoma).

Research as a state policy (H. L. Dodge, Oklahoma).

Conservation from a biological standpoint (C. E. Sanborn, Oklahoma).
Research in secondary schools (A. F. Reiter, Oklahoma).
The possibility of the redemption of the great plains from their semi-arid condition (J. B. Thoburn, Oklahoma).
Church and science (I. F. Lewis, Virginia).
Some reactions of man to platinum (J. L. Howe, Virginia).
What is science? (L. B. Richardson, New Hampshire).
A skeptical inquiry into the creed of science (W. B. Van Arsdel, New Hampshire).
The open mind (W. C. O'Kane, New Hampshire).
Backgrounds (F. H. Foster, New Hampshire).

The academy secretaries were asked in what way their academies cooperate with state departments and state organizations, with a view to making known the resources and advantages of their respective states. Ten academies make a definite effort to cooperate in this way, five cooperate only a very little, while four answer the question in the negative. The following are mentioned as avenues for cooperation: close contact with the State Educational Association, making the meetings as educational as possible, publication of papers on surveys, working with the State Conservation Commission, fostering research, having representatives of the state departments read papers and take part in the discussions, maintaining a conservation committee, acting in an advisory capacity to state departments on scientific matters, placing papers at the service of the public, supplying scientific information to the state legislature, keeping tab on legislation affecting scientific interests, having papers on the resources of the state, and offering the services of the academy to the governor in the capacity of an advisory scientific body to the state. Cooperation seems to be a reversible reaction. In Iowa a plan is on foot for the state to appropriate $2,000 or $3,000 for a biological and natural history survey of the state, the academy to furnish the experts. In Illinois the state surveys contribute papers to the Academy Transactions and the Transactions are published by the state.

Closely associated with the topic just considered are the replies to the question, "in what other way does your academy contribute to the scientific progress of your state?" Two secretaries say their academies contribute nothing, one is doubtful, another recognizes ungrasped opportunities by saying, "I am afraid we have done very little," while fifteen mention specific ways in which they justify their existence. The secretary of the North Carolina Academy, Dr. H. R. Totten, mentions the largest number of ways: That academy publishes important papers read at meetings and abstracts of the others, works for better scientific teaching in high schools, supplies speakers for educational meetings and for high schools, offers a state prize for the best essay by a high-school pupil on a scientific subject, keeps in close touch with the State Department of Education, arouses interest in the American Association for the Advancement of Science, and works for freedom of thought, of research and of teaching.

Several other secretaries send lists nearly as long. The following may be mentioned in addition: arousing public interest in scientific matters, backing legislative bills of a scientific nature, publishing papers primarily for non-scientific readers, conducting symposia for teachers in high schools, making the American Association for the Advancement of Science annual allowance available for grants for scientific work, encouraging graduate students to do research work, endorsing public movements like those for national parks, conducting a bureau of information at the service of the people, presenting non-technical lectures, publishing results of research connected with state affairs, encouraging beginners in science, fostering higher standards of scientific work in the state, and offering prizes or financial aid to meritorious projects. Though some of these items are plainly adapted to restricted and local use, still they supply suggestions for future activity to any academy that is looking for some new way to serve its state.

The question, "Do you have interchange of speakers, of ideas, or of reports on scientific work with other academies and if so to what extent," brought out the fact that ten academies practice no such interchange, while five have only occasional interchange. The secretary of one of the latter said, "Only occasionally and then rather accidentally." Four secretaries mention having out-of-state speakers, not always, however, drawn from the academy of a neighboring state. Three academies have had a joint meeting with a neighboring academy. One (Illinois) has an "out-of-state speaker for the complimentary address to the public." Another (Maryland) invites all visiting scientists to attend its lectures. One (Tennessee) "very rarely" has interchange, but the secretary adds, "I hope to see organized during the meeting of the American Association for the Advancement of Science in December, 1927, a Federation or Union of State Academies which will promote these things." Three academies (Illinois, Ohio and Oklahoma) exchange their publications with the other state academies, Oklahoma exchanging "widely, both in America and abroad." It thus appears that closer relationship among the state academies would be very helpful in general and it is clear that this feature of academy work is apt to receive more attention in the future.

Only four academies have museums. The Maryland Academy has done most along these lines. Having started with the Peale Museum, in 1797, it now maintains a constantly developing museum of science and natural history, housed in its own building and freely open to the public from 9 A. M. to 4 P. M., after which hours it is open only to members. The Kansas Academy has merged its museum with that of the State University. The Indiana Academy is cooperating with the State Museum and with the local historical societies in extensive mound exploration and is depositing all its material in the State Museum. The North Carolina Academy maintains no separate museum, but members of the State Museum are active in the academy and there is close cooperation.

Nine academies have no libraries. Two have no separate libraries; Iowa deposits its books in the state library, while Michigan has merged its library with the State University Library. Eight academies have libraries: Tennessee "only a few volumes, just beginning"; Illinois about the same; Ohio about 300 volumes; Kansas 4,000; Indiana 6,000, and Wisconsin several thousand volumes and 700 exchanges. The Indiana Academy library is in the same building with the State Library; the Wisconsin Academy library is incorporated with that of the State University. The Oklahoma Academy library is handled as part of the State University Library, but books are cataloged and shelved separately and book-plated "Academy." Provision is made for the removal of all academy books at any time. Most of these academy libraries aim to be extensive collections of scientific literature in general, rather than smaller collections of such reports of scientific investigation as the members might not find in their university libraries. The Maryland Academy library, however, contains many rare scientific volumes.

The Maryland Academy is the only one on our list that owns its own building. The fact that nine academies are incorporated shows that they are looking forward to future material resources and broader activities.

All academies but two (Georgia and New Orleans) issue some kind of a publication. *Proceedings, Transactions, Journal* and *Annual Reports* are titles most frequently used. *Abstracts* as a title is used once, as also is *News-Letter*. These printed reports vary in size from a 20-page pamphlet to a 450-page volume; they average perhaps 150 pages per year. In eight cases the publication is financed from the dues or general fund of the academy. In five cases the state finances the undertaking; in two out of these five cases (Indiana and Wisconsin) the state appropriates $1,500 annually. In two states (Michigan and Oklahoma) the state university pays for part or all of the academy report. The academies of Nebraska and Oklahoma are planning endowments to take care of all the publication expenses. For the North Carolina Academy the Proceedings are published by the Journal of the Elisha Mitchell Scientific Society, of the University of North Carolina, the university and the academy dividing the expense between them. The extent to which state academies have gone into the publication of reports is shown by the fact that the Indiana, Iowa and Kansas academies have each published over thirty volumes. Several of the publications are well illustrated. Alabama publishes simply abstracts of its papers in pamphlet form. New Hampshire has not yet entered the printed-page field, but it has furnished to its members mimeographed *News-letters,* somewhat irregularly, but on the average of about one a month. These contain the programs and announcements of the meetings, abstracts of papers read, and—what does not appear in any of the literature received from the other academies—news items about the members. In this last respect we appear to be a step ahead of the procession.

In another way the New Hampshire Academy appears to stand alone; no other academy has published any handbooks of its state, such as the Handbook of the Geology of New Hampshire, prepared by Professor J. W. Goldthwait for the academy and financed from the academy funds.

* * *

If we take as a starting point the foregoing outline of what the twenty-one affiliated academies have accomplished in the various states and how those accomplishments have been brought about, we may now look into the future through the lenses of what appear to be present opportunities, to secure some suggestions for the further development of the academy idea. It seems perfectly clear that state academies of science have been and are very valuable indeed, not only to their members but also to the progress of science and education in general in their respective states and consequently to the public at large. Such a conclusion is strongly supported in a very notable way by the enthusiastic and cordial response with which the academy secretaries to whom our questionnaire was sent have responded to our questions. As has been said, many of these secretaries, all of whom are very busy men, answered our queries with much more than perfunctory care; their replies indicate a very high degree of painstaking interest and enthusiasm for the work of their academies and for the cooperation of these organizations through their official affiliation with the American Association. To these secretaries is primarily due

any value that lies in the present paper and to them I wish to express my cordial thanks.

Besides reflecting their own faith in the work of their academies and the similar and obvious faith of their fellow members, these replies from the secretaries of the affiliated academies also strongly reflect what appears to be a very wide-spread and general feeling that the work of the academies should be strengthened and broadened more and more through alertness to take advantage of all opportunities that may arise in each case. As a concluding part of this paper I may mention some of the kinds of opportunities that seem to lie before these organizations, as such opportunities have been suggested by this study of the affiliated academies. These suggestions may be classified in two groups, opportunities for strengthening and enlarging the work of each academy in its own state and opportunities for broader and more active cooperation among the several academies, for mutual help and for the advancement of science and education throughout the country as a whole. It will be convenient and perhaps most serviceable to present these two categories of suggestions from the standpoint of our own New Hampshire Academy, with which I am naturally best acquainted.

From the standpoint of our own work in our own state, the following suggestions are tentatively put forward:

1. We might continue to increase our membership, to enroll with us all persons in New Hampshire who legitimately belong with us through their work and interests. This implies an active and continuous campaign to attract new members.

2. We might make our news-letters so interesting that those publications might aid greatly in holding, as non-resident members, all members who move into other states.

3. We might put into operation the plan that Secretary Hartshorn and myself outlined last June (for reasons that seemed to us good and sufficient it could not be put into complete operation this year): *viz.*, to bring out the *News-letter* regularly—as on the fifteenth of each month—and to give it such interest that members would look forward to its coming each month.

4. We might show our appreciation of the really remarkable little "Handbook of Geology" which Professor Goldthwait has generously written for our academy, by increasing its circulation as rapidly as possible and preparing for a second printing.

5. We might logically select from the fauna, flora, forestry, mineralogy or ornithology of New Hampshire suitable subjects for one or more additional handbooks, starting the preparation before the call for such service to our state, which is becoming manifest, has become so loud that we may seem to be neglecting our opportunities.

6. We might try to attract to our academic fraternity the workers in our state departments, adopting some of the relationships which have been found advantageous in other states and thereby bringing about increased and enlivened cooperation between state departments and the academy.

7. We might develop especially the interest we have already shown in the educational problems of our state, as by offering our services in connection with the numerous educational activities. This might be accomplished through cooperation with the State Department of Education or independently. The academy might undertake to furnish speakers on scientific subjects wherever such speakers are desired.

8. We might contribute more than we now do to the scientific progress of our state by organizing surveys of local conditions, and by spreading the gospel of improving unfavorable conditions through the greater use of scientific (meaning sensible) methods of procedure.

9. We might begin to look forward to and plan for an academy museum and an academy library, well housed and located as centrally as possible in the state, in charge of a permanent curator and librarian who might act as a bureau of information on academic matters of interest to our members. Such an academy museum might house (1) specimens of animal life (native, wild, migratory, and perhaps domestic) found in New Hampshire, (2) specimens of New Hampshire's wild and cultivated plants, (3) exhibits of woods indigenous to the state, (4) specimens showing geological structure and mineral deposits, (5) models of geographical features, (6) exhibits illustrating prominent industrial and educational activities, (7) photographs and charts bringing out prominent scientific features of the state and scientific discoveries made by our citizens, etc.

An academy library might house files of the reports and proceedings of state academies of science and of other similar organizations. It might include scientific publications specially related to New Hampshire or to work being carried on by members of the academy. A special section might be devoted to scientific works published by New Hampshire men. It seems that academy museums and libraries should aim to present and emphasize the interrelations of the different fields of knowledge, especially the close relation between the welfare and happiness of our people and the application of scientific knowledge to every-day affairs. This is perhaps the main burden of the new humanistic revival that seems to be getting so well started throughout the world. It does not

seem generally desirable that such collections should to any great extent duplicate specimens or volumes already available nearby. They might well bring out the various features of the wealth of their respective states. They might be very valuable in connection with the development of the industries of their states.

In a broader way, helping ourselves by cooperation with others, our New Hampshire Academy is surely ready to take part in activities aiming toward the general cooperation of the academies that are affiliated with the American Association for the Advancement of Science. Because state academies of science are generally much alike in their organization and are confronted with similar problems, frequent and free interchange of ideas and experience would undoubtedly be beneficial to all. There is a strong movement toward the realization of such cooperative interchange and that movement has been fully recognized by the American Association, which has already furnished valuable aid to the academies affiliated with it. A special committee on academy relations has recently been formed, including representatives of all the affiliated academies and of the executive committee of the association. We expect the new committee to study the problems of academy work and to make suggestions and inaugurate facilities for much progress in inter-academy relationships, making use of the already well-established organization of the American Association. Each affiliated academy has a representative in the council of the association, being thus in direct touch with association affairs, and the academy secretaries are in close relation with the Washington office of the association. The permanent secretary, Dr. Burton E. Livingston, has informed me that he is enthusiastic about the new academy movement and that the facilities of the Washington office are at the disposal of the affiliated academies in all feasible ways. He has expressed the hope that the affiliated academies may soon become virtually local branches of the larger organizations. They stand for the advancement of science in their several states in somewhat the same way as the association has so long stood in the country as a whole.

Several tentative suggestions as to ways in which our New Hampshire Academy might cooperate with the other state academies and with the American Association are mentioned below, but it is clearly realized that considerable study by representatives of all the academies will be needed before such suggestions may be relatively evaluated.

1. We might invite representatives of other academies to our meetings.

2. We might encourage our secretary to carry on correspondence with the secretaries of other academies, reporting interesting points and suggestions to our council or to our academy as a whole from time to time, perhaps occasionally through the *News-letter* if such an arrangement can be made.

3. We might encourage a similar correspondence between our academy and the permanent secretary of the American Association. Dr. Livingston has said that he will be glad to do his part.

4. We might aid the American Association to secure the attendance of official representatives of the association at our meetings. The association has approved of such representation, but the plan has not yet been generally realized.

5. We might arrange for occasional joint meetings with near-by academies if that proves feasible.

6. We might aid the science workers of other states to establish state academies where there are none at present, hoping that newly-formed state academies might become affiliated in our group with the American Association.

7. We might do what we can toward securing the general realization of the common aims of all the academies through inter-academy cooperation and with help from the association.

With the "Backgrounds" shown us a year ago by Mr. Foster in his presidential address; with a realization of what the New Hampshire Academy of Science has accomplished in the eight years of its existence; and with the courage and faith of a Lindbergh to turn the opportunities of to-day into the realities of to-morrow, let us say, as did Professor B. S. Hopkins, the discoverer of Illinium, in his inaugural address before the Division of Chemical Education of the American Chemical Society at the Richmond meeting last April: "Hats off to the accomplishments of the past; coats off to the accomplishments of the future."

WILHELM SEGERBLOM

HESPEROPITHECUS APPARENTLY NOT AN APE NOR A MAN

IN February, 1922, Mr. Harold J. Cook, a consulting geologist and paleontologist of Agate, Nebraska, sent to Professor Osborn an isolated fossil molar tooth which he had found in the Snake Creek beds of western Nebraska. He regarded it as closely approaching the human type and requested Professor Osborn and his colleagues to examine and describe it. After careful study and comparisons Professor Osborn published an article in the *American Museum Novitates* (April 25, 1922) entitled *"Hesperopithecus,* the First Anthropoid Primate found in America." In this brief article the author described the molar as the type of a new genus and species, which he named

Hesperopithecus haroldcookii, "an anthropoid of the Western World, discovered by Mr. Harold J. Cook."

In the type specimen the crown of the tooth had been ground off by long wear to such a degree that the surface of the crown was entirely gone and only the very basal portion was left. This presented an evenly concave surface of wear that was strikingly similar to the worn-down surface of one of the upper molar teeth that had been found by Dr. Dubois at Trinil, Java, near the famous skull top of *Pithecanthropus erectus.* The Nebraska tooth also had a very wide root on the inner side, which was similar to the wide root on the inner side of the upper molars of *Pithecanthropus* and of many teeth of American Indians. Hence Drs. Gregory and Hellman, whose report was cited by Professor Osborn, were inclined to think that on the whole the nearest resemblances of the specimen were with men rather than with apes. Professor Osborn stated that "this second upper molar tooth is very distant from the gorilla type, from the gibbon type, from the orang type; among existing anthropoid apes it is nearest to m^2 (the second upper molar) of the chimpanzee, but the resemblance is still very remote." After comparing it with the upper molars of the known fossil apes of Asia, as well as with the tooth of an American Indian, the author concluded that it was a new and extinct type of higher primate and that we must seek more material before we could determine its precise relationships to hitherto known races of men and of anthropoid apes. Professor Osborn also alluded to the fact that since 1908 there had been in the American Museum another badly water-worn tooth from the same formation and that Dr. W. D. Matthew had long been inclined to regard that specimen as pertaining to an anthropoid ape.

The scientific world, however, was far from accepting without further evidence the validity of Professor Osborn's conclusion that the fossil tooth from Nebraska represented either a human or an anthropoid tooth. Many authorities made the objection "Not proven," which is raised to nearly every striking new discovery or theory, and in course of time nine suggestions were put forward by responsible critics as to what the type specimen of "*Hesperopithecus*" might represent other than any kind of ape or man. Accordingly, Professor Osborn requested Drs. Gregory and Hellman to consider these suggestions and to present a more detailed report on the already famous specimens.

The first report of these authors is given in the *American Museum Novitates,* January 6, 1923. In their analysis of characters of the type they endeavored to distinguish four categories: (1) characters due to long exposure to weathering, erosion and stream action; (2) characters due to extreme natural wear of the crown; (3) chief characters that the *Hesperopithecus* tooth shares with both man and the anthropoid apes; (4) characters peculiar to *Hesperopithecus.* They published a series of photographic views in which the type specimen of *Hesperopithecus* was compared with upper molars of the chimpanzee, of *Pithecanthropus* and of the modern American Indian. They gave a table of measurements in which the dimensions and proportions of the type were compared with similar data for the molars of chimpanzees, of *Pithecanthropus* and of American Indians, concluding that the *Hesperopithecus* type on the whole came nearest to the second upper molar of a chimpanzee. They also published a series of radiographs which showed marked resemblance in the pulp cavity and roots to both chimpanzee and Indian molars.

In the second report by Drs. Gregory and Hellman on the *Hesperopithecus* problem (published in the *American Museum Bulletin,* December 4, 1923) the chief results are that after extended comparisons the authors concluded that the specimen could not represent a lower molar of any carnivore, that none of the other suggestions as to its possible relationships had proved tenable, that the greater number of resemblances of the type appeared to be with the gorilla and the chimpanzee rather than with the orang. It was also noted that "one of us (M. H.) still regards the human resemblances as being of considerable significance, while the other (W. K. G.) leans toward the anthropoid affinities of the type. The range of variability in crown and root characters of the molars both in the Hominidæ (human family) and the Simiidæ (anthropoid ape family) is so great and so overlapping as to warrant either interpretation." In view of the foregoing, the authors concluded that the "exact generic diagnosis of *Hesperopithecus* must await further discoveries."

In the hope of discovering more remains of this highly interesting fossil, Professor Osborn sent Mr. Albert Thomson, of the Museum staff, to collect in the Snake Creek beds of Nebraska in the summers of 1925 and 1926. At different times Mr. Thomson was joined there by Mr. Barnum Brown, Professor Othenio Abel, of Vienna, Professor Osborn and the writer. Among other material the expedition secured a series of specimens which have led the writer to doubt his former identification of the type as the upper molar of an extinct primate, and to suspect that the type specimen of *Hesperopithecus haroldcookii* may be an upper premolar of a species of *Prosthennops,* an extinct genus related to the modern peccaries. Some of these teeth have the crown worn down and more or less similar to the type of *Hes-*

Aegyptopithecus, in others the crown is much less worn and directly comparable with the relatively unworn premolar crowns of *Prosthennops serus* (a well-preserved palate of which had been discovered in an earlier expedition), while still others reveal more or less intermediate conditions. Moreover, the lower teeth which are apparently associated with these upper premolars are unquestionably the same or nearly the same as the corresponding lower teeth of *Prosthennops.* The still weak link in the chain of evidence consists in the fact that in *Prosthennops* the premolars that approach the type tooth of *Hesperopithecus haroldcookii* have two inner roots, whereas the type tooth has a single broad root.

This apparent difficulty may perhaps be met by the hypothesis that the type specimen is a second upper premolar, a tooth which in *Prosthennops serus* has only a single root; on the other hand, the type is far larger than any known *Prosthennops.* This much may be said: Nearly every conspicuous character of the type can be matched in one or another of the *Prosthennops* teeth. Thus, the concave wearing surface of the type is closely approximated in a certain worn upper molar of *Prosthennops*; the sharp ending of the enamel on the neck is seen also in the same specimen; the form and direction of the roots are closely paralleled in a third. Another upper molar (found by Professor Abel) and identified by him as *Hesperopithecus,* in the light of later finds is demonstrably *Prosthennops.*

It is hoped that further exploration this summer (1927) will secure sufficient material to remove all doubt in this matter.

Postscript

Last summer (1927) Mr. Thomson made further excavations in the exact locality where the type of *Hesperopithecus haroldcookii* was discovered. A number of scattered upper and lower premolar and molar teeth were found in different spots, but every one of them appears to me to pertain to *Prosthennops,* and some of these also resemble the type of *Hesperopithecus,* except that the crown is less worn.

Thus it seems to me far more probable that we were formerly deceived by the resemblances of the much worn type to equally worn chimpanzee molars than that the type is really a unique token of the presence of anthropoids in North America.

William K. Gregory
American Museum of Natural History

A NEW THEORY OF POLYGENIC (OR NON-MONOGENIC) FUNCTIONS

If we consider an independent complex variable

$$z = x + iy$$

and a dependent complex function

$$w = \varphi(x, y) + i\psi(x, y)$$

then in general the limit of the increment-ratio $\frac{\Delta w}{\Delta z}$ depends not only on the point (x, y) but also on the direction or slope m. The function is called *monogenic* in the classic case where the limit is independent of m, so that it has only *one* value at a point. I have proposed recently (in my lectures at Columbia University, and in communications to the National Academy and to the American Mathematical Society) the new term *polygenic* to describe the case where the limit has *many* values at a point, one for each slope. Thus for a polygenic function the derivative is not a function of (x, y) or z, but of x, y, m. We write therefore the derivative in the form

$$\frac{dw}{dz} = \gamma = \alpha + i\beta = F(x, y, m).$$

We plot $z = x + iy$ in a first plane, $w = u + iv$ in a second plane, and $\gamma = \alpha + i\beta$ in a third plane.

To each point in the first plane corresponds one point of the second plane, but ∞^1 of the third plane (which we also call the derivative plane).

The locus of these points is always a circle. This is true for any polygenic function. The equation of the circle is

$$(\alpha - H)^2 + (\beta - K)^2 = h^2 + k^2 = R^2$$

where

$$2H = \varphi_x + \psi_y, \qquad 2K = -\varphi_y + \psi_x,$$
$$2h = \varphi_x - \psi_y, \qquad 2k = \varphi_y + \psi_x.$$

(In the special case where the function w is monogenic the circles of course all shrink to points, since in virtue of the Cauchy-Riemann equations h and k vanish so that the radius R is zero.)

To the ∞^2 points of the first plane correspond ∞^2 circles (in general distinct), that is, a congruence of circles. We call this the *derivative circular congruence* of the given polygenic function.

Thus while the transformation from the first plane to the second plane is a point transformation, the passage from the first to the third plane gives rise to a contact transformation.

Many noteworthy classes of polygenic functions are obtained by specializing the congruence. Thus if the congruence degenerates into the ∞^1 circles with the center at the origin, the function is of the form

$$w = f(x - iy)$$

that is an analytic function (power series) of the conjugate complex variable. If the circles all go through the origin, the components φ and ψ are dependent, that is the Jacobian must vanish. If the centers all lie on the axis of α, then we obtain the special form

$$w = W_x + iW_y,$$

where W is an arbitrary function of x and y. And so on.

Returning now to the general theory, we state this fundamental and easily proved theorem:

As the direction or slope m varies at a given point of the first plane, the corresponding point γ moves on the derivative circle in the third plane so that its angular rate is always twice that of m and in the opposite sense.

Therefore the complete picture of the derivative $\frac{dw}{dz}$ is not a congruence of circles but a *congruence of clocks.* Here I use the word *clock* to denote a circle with a particular distinguished radius vector. We select this to correspond to the direction $m = 0$ at the point in the $z-$ plane. Thus a clock is completely determined by two vectors, namely the central vector $H + iK$ and the phase vector $h + ik$.

From the above theorem it follows that there are just *three* directions m which are parallel to the corresponding radii of the derivative circle, and that these radii are spaced at intervals of 120°. Since this is true at any point, we obtain by integration a triple family of curves (which we call the *equiangular family*) in the first and third planes.

We next define the *mean derivative* of a polygenic function as the mean value

$$\frac{1}{2\pi}\int_{)}^{2\pi} \frac{dw}{dz}\, d\vartheta \text{ where } \tan\vartheta = m.$$

The result is found to coincide with the center of the derivative circle. Hence, using the symbol $\mathfrak{D}$ for mean differentiation, we have this fundamental formula

$$\mathfrak{D}(\varphi + i\psi) = H + iK = \frac{\varphi_x + \psi_y}{2} + i\,\frac{-\varphi_y + \psi_x}{2}$$

We verify the symbolic equation

$$\mathfrak{D} = \frac{D_x - iD_y}{2}$$

where D_x and D_y denote partial differentiation. We thus obtain easily positive and negative powers of this operator.

The mean derivative of a monogenic function is of course a monogenic function. The converse however is not true.

The mean derivative of a polygenic function is sometimes monogenic. This occurs when and only when φ and ψ obey Laplace's equation, that is, when φ and ψ are any harmonic functions.

For this type of harmonic polygenic function, the transformation from the point $x+iy$ to the point $H+iK$, which we call the *induced center transformation* and denote by T', is conformal (direct), though the transformation T from $x+iy$ to $u+iv$ is in general not conformal. We shall call T in this case a *general harmonic transformation.* This class of transformations, which does not form a group, includes the total conformal group (made up of direct and reverse conformal transformations) as a special case.

Further developments of the general theory will be published in the Proceedings of the National Academy of Sciences, the Comptes Rendus, and the Transactions of the American Mathematical Society.

EDWARD KASNER

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SCIENTIFIC EVENTS

REPORT OF THE PRESIDENT OF THE CARNEGIE INSTITUTION

THE trustees of Carnegie Institution of Washington met in annual session on December 9, Elihu Root presiding. In recognition of the fact that the institution is completing a quarter century of activity, President Merriam, in his formal report covering the work of the institution for 1926–27, briefly characterized the policies of the quarter century.

He said that in the first years the institution's grants were commonly made for specific projects to run for limited periods. These covered a relatively wide range of subjects, affording an important stimulus to many types of agencies. In later years the tendency developed to center upon major projects which required sustained effort and concentration of funds. This tendency resulted in the development of departments in the institution's organization, each devoted to its specific subject and under leadership of an investigator of exceptional vision and ability. Although the practice of giving minor grants to distinguished individuals for special projects was continued, in many cases advantage was found in relating such problems to that department of the institution best fitted to cooperate. Still more recently a relation between departments has developed comparable to that which had developed in some instances between departments and individual investigators.

President Merriam summed up his observations on the institution's policy as it has evolved during the quarter century by saying:

> The institution to-day contains all the elements that have arisen in the course of study of its problem. There are still widely distributed special grants. The greater departmental activities still represent concentrated effort in specific fields. The increasing mutual support has not diminished initiative of the individual or of the group, but it has added an element which with the passing of time becomes more and more valuable, both in effort to concentrate upon special projects and in keeping that view of the larger field so desirable in long-continued researches.

Plans involving an expanded program of activities in the fields of early American cultures and of plant biology were also referred to by the president.

In respect to the first of these he said that the specific investigations heretofore undertaken by the institution in American archeology had been initiated in the hope that they might lead to some suggestion of laws which have governed in the development of the varying types of early peoples and cultures in America. He pointed out that the time had now come in the work of the Carnegie Institution in this field when the results should be interpreted in the light of what has been learned about the American problem in other regions and by other agencies.

The president also stated that Dr. Alfred V. Kidder, who has worked with distinction in early American history and is deeply interested in the wider aspects of the matter, has accepted leadership for the institution in its broadened activities in this field of research. This change implies no lessening of interest in the investigation of the Maya culture of Yucatan, for the results which the institution has obtained, he assured the trustees, amply justify adherence to its fundamental plan of furthering historical studies in Middle America.

In referring to proposed changes in the plant biology program the president said that during the past two decades the institution had attempted to advance the boundaries of knowledge by intensive effort at several critical points along the margin of the field. Such, he suggested, have been the researches in problems of life process in plant physiology, on the relation of life development to special types of conditions as in work at the Desert Laboratory, on the relation of life progress to environment, on problems of plant heredity, on questions touching relation of classification to heredity and to influence of environment and on problems presented by the history of plant life during the ages.

In 1926 a small committee of the institution's leading investigators in this field was asked to formulate a program for future guidance after full consideration of the matter. The report of this committee, the trustees were informed, indicates that a greater unity of attack would be profitable to all, without real loss or hardship and that a larger measure of unity in administration would facilitate the entire plant biology program.

President Merriam also spoke of the opportunity afforded the institution's investigators during the year of participating in international meetings. He believes that such meetings and the contacts with workers in related fields which they provide have distinct value. On this point he said:

> Through these relationships there has developed both the accumulation of materials arising from studies by other institutions and the contribution from our own researches, which are thus subjected to constructive review by experts in related fields. It is believed that such extension of our relationships is one of the important means to be used in finding how our own course should be steered in the unknown fields toward which we are always moving.

Dr. Merriam presented to the trustees a report covering in detail the progress of research carried on by the institution during 1926–27. This will soon be available for distribution in the form of *Year Book*, No. 26.

The trustees upon completing the business of the day spent the afternoon with their friends in viewing the exhibition prepared by members of the institution staff. This exhibition, which is set up at this time every year at the Administration Building, Washington, D. C., is designed to show the progress made in significant research activities. For three days following the annual meeting of the board of trustees, December 10, 11 and 12, the public generally was invited to view the exhibits.

EXPLORATIONS IN ALASKA BY THE U. S. GEOLOGICAL SURVEY

THE U. S. Interior Department announces the completion of the field work of another exploratory expedition in Alaska by the Geological Survey and the bringing back of maps and information regarding a tract of more than 2,000 square miles in the Alaska Range and adjacent country on the west side of Cook Inlet, in the environs of Mount Spurr, that has hitherto been shown as a blank area on all authoritative maps. This exploration is one of the series that the Geological Survey has been making throughout the last thirty years. The party consisted of S. R. Capps, geologist in charge; R. H. Sargent, topographic engineer, and four camp men. Transportation in the field of the necessary provisions, supplies and equipment for 100 days was furnished by a pack train of fifteen horses. From the time when the party landed at Trading Bay, on the west side of Cook Inlet, about the middle of June, until it returned to that place at the end of the field season, about the middle of September, the members were entirely out of communication with the rest of the world.

Among the many items reported are the discovery and mapping of a large river, numerous lakes, glaciers and mountains and an active volcano. The newly discovered large river is the Chakachatna, whose drainage basin covers an area of more than 1,100 square miles. This stream is a roaring torrent far too swift and too deep to be forded even with horses; in fact, measure-

ments of its current at several places showed that it was flowing at an average speed of 15 miles an hour. This river rises in a superb lake, Lake Chakachamna, 23 miles long, which is hemmed in between lofty mountains and impounded behind a great glacier that lies athwart the general trend of the valley. The distribution of the rivers that head against the Chakachatna can now be predicted with considerable assurance. Thus, to the south are rivers that probably flow in part into Lake Clark; to the west and northwest are tributaries of Stony River and of the South Fork of Kuskokwim River.

Many of the mountain peaks are ragged pinnacles which could be climbed, if at all, only with great difficulty. The highest peak of the region is Mount Spurr, which rises to an altitude of 11,000 feet and is clearly visible from the coast. Although the flanks of this mountain are in large part covered with perpetual snow and glaciers, the mountain was found to be an old volcano that is still active. When the weather was favorable a plume of steam could be seen rising from a point near its crest to a height of more than a thousand feet. This discovery therefore establishes Mount Spurr as the most northerly of the long series of known active volcanoes that occur at intervals along the west coast of Cook Inlet and extend westward into the Alaska Peninsula and Aleutian Islands.

ENDOWMENT FOR THE ARNOLD ARBORETUM

FRIENDS of the late Professor Charles Sprague Sargent and others interested in the Arnold Arboretum of Harvard University, in Jamaica Plain, on November 30 gathered at Sherry's Restaurant, New York City, to hear of plans for the completion of a $1,000,000 endowment fund for the arboretum. The fund, about $600,000 of which has been raised since Professor Sargent's death last March, will be used to perpetuate the great botanical station as he had planned it. About 500 persons attended the dinner, held under the auspices of the New York committee.

David Fairchild, agricultural explorer in charge of foreign plant introduction for the U. S. Department of Agriculture; Professor Oakes Ames, present supervisor of the arboretum and successor to Professor Sargent, and the Right Reverend William Lawrence, formerly Bishop of the Episcopal Diocese of Massachusetts, were the speakers. All urged support of the arboretum, painting it as a vital part of the country's life and as a great power both in the economic world and for the beauty of the nation.

It was announced on December 3, by Mr. J. P. Morgan, who is acting as treasurer, that since the opening of the New York campaign to raise part of the proposed $1,000,000 endowment fund for the arboretum, $109,250 has been contributed by New Yorkers.

A gift of $50,000 to the fund has been offered by Edward S. Harkness, on condition that the New York committee match the $460,000 already contributed in Boston.

New York contributors to the fund so far are Moreau Delano, $25,000; J. P. Morgan, $20,000; Mrs. Harold I. Pratt, $15,000; Mrs. W. Bayard Cutting, $5,000; William Adams Delano, $5,000; T. A. Havemeyer, $5,000; Mrs. James H. Metcalf, $5,000; Charles A. Stone, $5,000; William Nelson Cromwell, $2,500; Henry W. de Forest, $3,000; John E. Aldred, $2,500; R. W. de Forest, $2,500 plus $500; J. N. Jarvie, $2,500; anonymous, $1,000; Paul D. Cravath, $1,000; Mrs. Max Farrand, $1,000; Mrs. W. L. Harkness, $1,000; Clarence Hay, $1,000; Charles Hayden, $1,000; G. O. Muhlfeld, $1,000; Anton G. Hodenpyl, $500; Mrs. Arthur Curtiss James, $500; Mr. and Mrs. A. R. Graustein, $500; Victor Morawetz, $500; W. H. Bush, $250; O. M. Eidlitz, $250, and Elihu Root, $250.

THE FIRST MEETING OF THE COLORADO-WYOMING ACADEMY OF SCIENCE

THE first meeting of the Colorado-Wyoming Academy of Science was held on November 25 and 26, at the University of Wyoming. The new organization has an initial enrolment of 166 members chiefly from the eight educational institutions of these two states.

Sectional meetings were held in the new engineering building of the University of Wyoming and forty-one papers were presented on chemistry, physics, botany, zoology, geology and social science. At the business meeting on the afternoon of the second day the constitution was formally adopted and the following officers elected:

Dr. Aven Nelson, University of Wyoming, *President.*
Dr. O. C. Lester, University of Colorado, *Vice-president.*
Dr. L. W. Durrell, Colorado Agricultural College, *Secretary.*
Dr. E. B. Renaud, University of Denver, *Treasurer.*

Closing the session a banquet was given the members by the University of Wyoming.

SCIENTIFIC NOTES AND NEWS

THOMAS ALVA EDISON has been elected an honorary member of the British Institution of Electrical Engineers.

PRESENTATION of the Chandler medal by Columbia University will be made to Professor Moses Gomberg on December 15, when he delivers the Chandler lecture on "Free Radicals in Chemistry—Past and Present."

DR. WILLIAM J. MAYO, of Rochester, has been named a commander of the Royal Order of the North Star by King Gustav of Sweden.

PRINCE ALBERT DE LIGNE, ambassador to the United States from Belgium, conferred on Dr. Chevalier Jackson, chief of the bronchoscopic clinic at Jefferson Hospital, the Knighthood of the Order of Leopold, on November 22, at an informal luncheon in the Belgian Embassy, Washington, D. C.

AT the meeting of the British Chemical Society on November 8, Sir Joseph J. Thomson was elected an honorary fellow of the society.

THE Russian expert commission for the awarding of the Lenin prizes for scientific work has made awards to Professor A. N. Bach for work in the province of biological chemistry; to Professor V. P. Vorobyov, Kharkov, for work in anatomy; to Professor K. K. Gedroits for work in agricultural chemistry and soil science, and the late Professor L. A. Chugaye for work in the affinity of precious metals.

THE James Scott prize of the Royal Society of Edinburgh, for the period 1922–1926, "for a lecture or essay on the fundamental concepts of natural philosophy," has been awarded to Sir Joseph Larmor.

THE Royal Meteorological Society has awarded the Symons memorial gold medal for 1928 to Professor Hugo Hergesell, director of the Aeronautical Observatory, Lindenberg, for distinguished work in connection with meteorological science. The medal, which is awarded biennially, will be presented at the annual general meeting on January 18.

ALEX DOW, of Detroit, has been elected president of the American Society of Mechanical Engineers, succeeding Charles M. Schwab, chairman of the Bethlehem Steel Corporation. Vice-presidents are John H. Lawrence, New York; E. A. Muller, Cincinnati; Newell Sanders, Chattanooga, Tenn.; Paul Wright, Birmingham, Ala. The managers named are L. B. McMillan, New York; William A. Hanley, Indianapolis, Ind.; F. H. Dormer, Milwaukee, Wis.

SIR CHARLES CLOSE, formerly director-general of the British Ordnance Survey, has been appointed by the council of the Royal Geographical Society president of the society until the anniversary meeting next June in succession to Dr. D. G. Hogarth, who died on November 6.

DR. ROBERT F. MEHL has been appointed superintendent of the division of physical metallurgy in the Naval Research Laboratory, not director of the laboratory as was incorrectly stated in the last issue of SCIENCE. Captain D. E. Theeleen is director of the laboratory and Commander E. G. Oberlin is assistant director.

THE University of Manchester has conferred the title of professor emeritus upon Professor R. B. Wild on his retirement from the Leech chair of materia medica and therapeutics.

PROFESSOR SUSLOV, director of the Odessa Polytechnical Institute, has celebrated his seventieth birthday, in which the Odessa scientific circles largely participated.

LUDLOW GRISCOM has been appointed assistant director of the Harvard Museum of Comparative Zoology and has resigned from the assistant curatorship of ornithology at the American Museum of Natural History.

DR. WILBERT W. WEIR, associate soil technologist in charge of editorial work in the U. S. Bureau of Chemistry and Soils, has resigned to accept a position with the Chilean Nitrate of Soda Educational Bureau, New York.

PROFESSOR GROVER D. TURNBOW, head of the division of dairy industry at the University of California, has been given leave of absence to engage in commercial work.

AT Duke University, W. H. Hall, professor in charge of engineering, has returned after spending his year of leave at the University of Wisconsin. Harold C. Bird, who has been acting as professor of civil engineering during Professor Hall's absence, continues as professor of civil engineering.

DR. D. C. CARPENTER, associate chemist at the New York State Agricultural Experiment Station, who has been working for the past few years on the structure of the casein molecule, has been invited by Dr. T. Svedberg to make use of the centrifuge in his laboratory at the University of Upsala to ascertain the molecular weight of casein. Dr. Carpenter sailed for Sweden on December 9, under the auspices of the International Education Board, and will spend the coming year with Dr. Svedberg.

PROFESSOR JAMES H. BREASTED, director of the Oriental Institute of the University of Chicago, which has six expeditions in the field in search of records of lost civilizations, left Chicago on December 5 to inspect the work now in progress. Professor Breasted, his son Charles and his secretary, R. J. Barr, sailed from New York on December 10.

DR. P. J. VAN LONKHUIJKEN, director-general of health of the Netherland East Indies, is in the United States inspecting methods of public health and disease control employed by the U. S. Public Health Service.

DR. TETSUO INUKAI, professor of zoology in Hokkaido University, Sapporo, Japan, and Dr. T. G. Ahrens, ornithologist of Berlin, Germany, are visiting the United States.

PROFESSOR KIRTLEY F. MATHER, of the department of geology at Harvard University, will be in charge of an expedition composed of students from Harvard, Mount Holyoke, Northwestern, Clark, Oberlin and the Massachusetts Institute of Technology, which will travel to different points of geological interest in Europe next year. This expedition, which will supplant the annual trip to some mountain range in America, will last for twelve weeks.

DR. SIGMUND FRAENKEL, professor of medical chemistry at the University of Vienna, delivered five public lectures on "The Theory of Synthetic Remedies" at the University of California, from November 21 to December 2. Professor Fraenkel has spent a month in the laboratories of the university, collaborating with Dr. Herbert M. Evans, of the department of anatomy, on "Studies on the Chemistry and the Secretions of the Endocrine Glands."

THE Japanese correspondent of the *Journal* of the American Medical Association writes that Professor S. Tashiro, of the University of Cincinnati, accompanied by Professor Gustave Eckstein, has been visiting his native land. From the same university, Dr. Martin H. Fischer has gone to Tokyo and is to deliver lectures at different universities.

DURING the second semester 1927–1928, beginning on February 8 and continuing until May 26, the department of botany at the University of Illinois announces two courses in plant physiology to be given by Professor W. W. Lepeschkin, of the laboratory of plant physiology, Charles University, Prague. Professor Lepeschkin goes to the university as visiting professor, and will give half-time to his work in the department. The program has been so arranged that he will have the beginning and end of each week free for lectures at other institutions. Arrangement for such lectures may be made through the department of botany.

PROFESSOR LAFAYETTE B. MENDEL, of Yale University, has recently given lectures on "Some Aspects of Animal Growth" at the following places: October 28, Society of the Sigma Xi, McGill University; December 3, Royal Canadian Institute, Toronto; December 5, Society of the Sigma Xi, Cornell University, Ithaca.

PROFESSOR DUGALD C. JACKSON, of the department of electrical engineering at the Massachusetts Institute of Technology, lectured before the Franklin Institute on December 8 on "Illumination in the Industries."

PROFESSOR HENRY NORRIS RUSSELL, of Princeton University, lectured on December 9 at Smith College on "What are the Gaseous Nebulae?"

DR. OSCAR RIDDLE, of the station for experimental evolution at Cold Spring Harbor, N. Y., delivered a lecture at the Carnegie Institution of Washington on November 15 on "Internal Secretions in Evolution and Reproduction."

DR. SAMUEL R. DETWILER, professor of anatomy in the college of physicians and surgeons of Columbia University, gave two lectures on December 6 and 7 at Cornell University on "The Application of Embryonic Surgery to Problems of the Development of the Nervous System."

THE school of chemistry and physics of the Pennsylvania State College, in cooperation with the school of mines and metallurgy of the same institution, announces the second annual Priestley lectures, consisting of a series of five public lectures on "The Physical Chemistry of Metals and Alloys," by Dr. Samuel L. Hoyt, of the Research Laboratory of the General Electric Company, to be given daily in the chemistry amphitheater from January 16 to 20, inclusive, at 7:00 P. M.

A SYMPOSIUM in memory of Lister was given, November 30, by the section of historical and cultural medicine of the New York Academy of Medicine. The speakers were Drs. Thomas Archibald Malloch, George D. Stewart, John Tait, Montreal, and Fielding H. Garrison, Washington, D. C.

THE amalgamation of the Röntgen Society with the British Institute of Radiology was formally completed at a joint general meeting of members of the two societies on November 17. We learn from *Nature* that Sir Humphry Rolleston was elected president for the ensuing session, with Sir William Bragg, Dr. Kaye and Dr. Knox as vice-presidents. The president, in his inaugural address, referred to the history of the two constituent bodies and sketched the possibilities of the widened scope of activity which should follow the amalgamation.

LADY LYELL of Kinnordy has presented to the department of geology of the University of Edinburgh valuable collections of minerals, rocks and fossils, together with cabinets for keeping them. In addition, Lady Lyell has given many geological books, papers of historical interest and a collection of autographed letters from scientific workers of note to the late Sir Charles Lyell.

A CORRESPONDENT writes that the first fascicle of a work presenting the plants of China, entitled "Icones Plantarum Sinicarum," has been issued by the South-

eastern University at Nanking. The authors are Hsen-Hsu Hu and Woon-Young Chun. The large size (48 x 31 cm.) makes the handsome plates unusually impressive. This first fascicle is dedicated to Charles S. Sargent in memory of his interest in the woody flora of China. The fascicle contains fifty species and plates, the descriptions being in both English and Chinese.

THE chairman of the general committee of the American Society for the Control of Cancer has announced the completion of the society's $1,000,000 fund for which a campaign was started a year ago. The endowment will insure a minimum budget of $60,000 a year to continue the society's work. At the same time, Dr. George A. Soper, managing director of the society, announced that its educational bulletins had been published daily for the last two weeks in one hundred and twelve newspapers throughout the country.

NATURE states that members of the British Association have from time to time discussed the desirability of the association's applying for a royal charter. It has been felt that the association would be strengthened in its work for the advancement of science by the possession of a charter, but the cost involved has hitherto acted as a deterrent. Mr. A. A. Campbell Swinton has now generously offered to bear this cost, and the council has resolved to recommend the general committee to accept this offer and to authorize the president and general officers of the association to apply for a charter on its behalf. The possession of a charter would, moreover, enable the association readily to avail itself of a proposal made by Mr. George Buckston Browne, who, it will be remembered, offered to purchase Darwin's house at Downe for the nation, in response to the appeal made by Sir Arthur Keith in his presidential address at the Leeds meeting of the association. Mr. Buckston Browne has now expressed his desire that the trusteeship of the estate should be vested in the association, and the council will recommend the general committee to accept this further generous offer.

AN endowed fellowship for advanced astronomical students has been provided at Harvard through a gift to the observatory from Mr. George R. Agassiz, chairman of the Observatory's Visiting Committee. According to *Popular Astronomy* the holder of the fellowship is expected to carry on his researches at the Harvard Observatory, and preferably will be a candidate for a doctor's degree in Harvard University. The annual stipend will be not less than one thousand dollars. The present holder of the Agassiz research fellowship is Mr. Frank S. Hogg, B.A., Toronto, who has made investigations in stellar spectrophotometry at Harvard University during the past year.

IN the new quarters into which the department of physiology of the University of Chicago has recently moved, there is about three and one half times more space available for teaching and research than in the old building. At the present time thirty-seven individuals are engaged in research in the department. Aside from the teaching staff, research associates, volunteer workers, and graduate students specializing in physiology, there are eleven workers holding fellowships. These are distributed as follows: 3 Rockefeller Foundation fellows, 1 National Research Council fellow, 2 Douglas Smith Foundation fellows, 1 Seymour Coman fellow, 1 Donnelly fellow, 1 Hille fellow, 1 university fellow and 1 Sidney Walker, Jr., scholar.

THE museum of natural history of the University of Iowa, for many years an adjunct of the department of zoology, is now an independent unit, designed to meet the needs of the different departments and also those of the general public. By action of the president of the university, Professor Homer R. Dill has been made director of this new department. For a number of years Professor Dill has been director of the vertebrate museum.

ACCORDING to *Museum News*, the Fleischmann mammal wing of the Santa Barbara Museum of Natural History will be opened to the public for a week during the Christmas holidays. As only a part of the exhibits which are planned for this new addition can be in place at this time, it will be necessary to close the building again for further work, before the collections can be permanently placed before the public. Three large California habitat groups will be completed by Christmas. These include the mountain lions, California mule deer and coyotes. When the wing is permanently opened there will be other groups of tree squirrels, striped skunks, badgers, bob cats and foxes found in the state of California.

THE Brussels correspondent of the London *Times* writes that, on the initiative of King Albert and the great industrialists and financiers, a movement has begun for the creation in Belgium of a permanent museum and a laboratory for scientific research, which it is proposed to develop into a center of study, where all nations will be invited to exhibit in 1930 the best specimens of scientific equipment. An academic session, attended by the king, the ministers and the diplomatic corps, was held on November 25 at the Palais des Académies in Brussels to consider the opening of a national fund for scientific research. In his speech King Albert said that, though science created wealth, it was itself poor. They must come to its aid, in order

that scientific effort might develop in Belgium with as much freedom and vigor as in other countries. Men of science should be relieved of material cares, and thus be placed in a position to concentrate all their thoughts on research. Many gifts have already been announced.

ACCORDING to a statement made in the report of the French National Committee for Geodesy and Geophysics of the General Assembly held on June 8, 1927, that committee has decided to purchase an apparatus for the determination of gravity at sea similar to the one used for that purpose by Dr. F. A. Vening Meinesz, engineer of the Dutch Geodetic Commission, who has determined gravity at sea on a submarine while making a voyage from Holland to Java, by way of the Mediterranean, and a voyage from Holland to Java, by way of the Panama Canal.

INTENSIVE study of the effect of medicines on the human body will be made at a new research institution for internal medicine to be established by the Kaiser Wilhelm Society at Heidelberg, according to the German correspondent of the American Chemical Society. Among the investigators who will work on the staff of the new institution will be Professor L. Krehl, of Heidelberg University, specialist in international medicine.

ACCORDING to *Nature* the Slutzk, better known under its original title, Pavlovsk, observatory for meteorology and geophysics, celebrated on December 4 the fiftieth anniversary of its foundation. Well equipped with magnetic instruments designed by its first director, H. Wild, and for many years the most northern magnetic observatory in the world, Pavlovsk has supplied a long series of magnetic results, which have been utilized in many researches by foreigners as well as Russians. Observations in atmospheric electricity, begun in 1913, have supplied data of much interest in connection with the vexed question of the true nature of the diurnal variation of the potential gradient. Actinometry has also had a special place in the program of the observatory during the present century. Aerological work in Russia had its origin at Pavlovsk some thirty years ago, but it is now provided for in a separate institution. Foreign participation is invited in the approaching ceremony.

THE Berlin correspondent of the *Journal* of the American Medical Association writes that an exposition on human nutrition will be held in Berlin, from April 28 to August 5, 1928. The exposition will have to do chiefly with the scientific and practical demonstration of a suitable mode of nutrition involving only a reasonable cost. According to the plan of the exposition as tentatively announced, the main departments of the exposition will comprise: (1) the basis of nutrition; (2) food products, the technic of food products and the food products industry; (3) nutrition in practical life, and (4) education, instruction and literature pertaining to nutrition.

THE William H. Coleman Hospital for Women, Indianapolis, was opened on October 20, and formally presented to the University of Indiana by Mr. and Mrs. William H. Coleman, who gave more than $350,000 to build and equip the hospital as a memorial to their daughter.

PRESIDENT COOLIDGE has signed a proclamation segregating the Ocala division of the Florida National Forest as the Ocala National Forest. The new Ocala National Forest will have a separate administrative organization. Florida now has two national forests. The creation of the Ocala National Forest as a separate unit will further the growing of timber on the sandy soils, the protection of the area against fire, and the improvement of the area for recreational purposes. Game laws will be administered in cooperation with the state game department. The Ocala forest has a gross area of 252,000 acres, of which 158,622 are owned by the United States.

A GRANT has been voted by the legislature toward the expenses of a malarial survey of Jamaica, to be conducted by the International Health Board of the Rockefeller Foundation.

A BASE map of certain parts of the Mississippi basin, to be used in the study of flood prevention in the river region, has been issued by the U. S. Geological Survey. The territory embraced in the map extends from Dubuque on the north to the Gulf on the south, and from Omaha, Tulsa and Houston on the west to Chicago, Evansville and Tuscaloosa on the east.

THE London *Times* reports that the following communication received from the Selborne Society, signed by Lord Montagu of Beaulieu (president), Lord Avebury (vice-president) and Sir John Otter (treasurer), states: "Adjoining the Brent Valley golf links, in the Borough of Ealing, is an estate of seven acres, the greater part of the grounds of which have, from being left almost entirely untouched for 15 years or more, become a recognized haunt of birds, and many species are known to have nested there. These include the blackcap, the garden and willow warblers, the whitethroat and the moorhen. Wildfowl come to the lake which is formed by the perennial spring, and the goldfinch and green woodpecker are often to be seen. The Selborne Society has long wished to protect the ground in question, and at last there is an opportunity of acquiring it. It has been suggested that it would make a fitting memorial to the late W. H. Hudson, who helped the Selborne Society to establish the Brent Valley Bird Sanctuary

at Perivale, higher up the river, which, 25 years ago, set an example that has been widely followed of preserving for urban districts the interesting birds of the countryside. It will not be necessary for the Selborne Society to take over the mansion, but if funds allow, as this has been fitted up as a hospital by the government, two good things might be done at once, for it could most appropriately be placed at the disposal of some charitable organization, or it could be used as the beginning of a folk museum, which ought to be inaugurated in this country before it is too late. The property was advertised as for sale by auction in building plots a few days ago, but some members of the Selborne Society have, for the moment, saved it from this fate. Donations can, therefore, now be invited towards its purchase and maintenance, which should be sent to the treasurer, Sir John Otter, at the Hermitage, Hanwell, W.7."

UNIVERSITY AND EDUCATIONAL NOTES

NORTHWESTERN UNIVERSITY, which has announced plans for extensive improvement of its downtown campus, is preparing to add to its Evanston, Ill., campus a $750,000 union building.

DR. FRANK VINSONHALER, professor of ophthalmology at the school of medicine of the University of Arkansas, has been made dean of the school.

H. W. VAUGHAN, professor and animal husbandman in charge of beef cattle investigations in the University of Minnesota, has been appointed head of the animal husbandry department at the University of Montana.

JOHN LESLIE HUNDLEY, of the University of North Dakota, has been appointed assistant professor of physics at Tulane University.

E. D. COON has returned to the University of North Dakota as assistant professor of chemistry, after having spent a year's leave of absence at the University of Wisconsin, working under the direction of Professor E. O. Kraemer in colloid chemistry.

IT is stated in *Popular Astronomy* that Harry H. Plaskett, of the Dominion Astrophysical Observatory at Victoria, B. C., has been appointed lecturer in astrophysics in Harvard University, beginning February, 1928. A leave of absence for one year has been granted Mr. Plaskett by the Canadian government.

DR. OTTO STRUVE, of the Yerkes Observatory, University of Chicago, has been promoted to an assistant professorship of astronomy.

DR. D. S. VILLARS, who spent the past year at Göttingen in the laboratory of J. Franck, has been appointed associate in chemistry at the University of Illinois.

THE title of professor of chemistry in the University of London has been conferred on Dr. J. F. Spencer, in respect of the position held by him at Bedford College.

SIR EDWARD FARQUHAR BUZZARD has been appointed Regius professor of medicine in the University of Oxford from January 1, 1928, in the room of Sir Archibald Garrod, who has resigned.

DISCUSSION AND CORRESPONDENCE

THE PHYSICIST AND THE FACTS OF COLOR

THERE is probably not a single physicist who has gone so far in the analysis of his color-sensations as to know that the violet, which plays such an important rôle in his list of colors, is not a unitary color at all, but plainly a "dual color blend" of some red and more blue. It can be got not only by a certain homogeneous light-frequency, but also by a physical mixture of some red light and more blue light. It no more deserves a separate enumerating than do the other dual color blends, *viz.*, the blue-greens, the yellow-greens, the reddish-yellows and the bluish-reds (what we also call the purples). In Figure 1 is

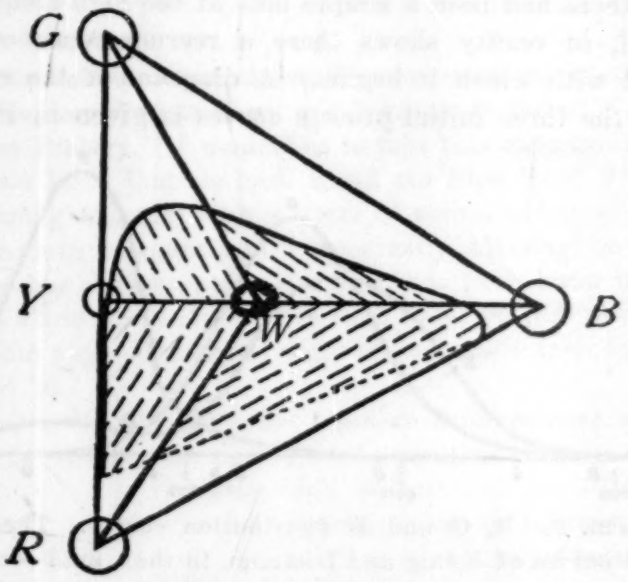

FIG. 1. The *quadrigeminal* color area—*triangular* in shape.

illustrated at once the two fundamental facts of color-vision: (1) the Young-Helmholtz fact that vision consists in a tri-receptor initial process (it is sufficient to put into your color-mixing-apparatus three fundamental light-frequencies—those which look to us red, green and blue); and (2) the Hering fact that vision (when it comes to sensation) is nevertheless tetrachromatic—there are four chromatic sensations—Yellow is just as good, just as striking and just as unitary a sensation as are Red and Green and Blue. (I write these names with capitals when the colors which

I refer to are unitary.) Figure 1 and Figure 2 are two different ways of representing diagrammatically the fundamental facts of color-vision—the fact of "matching by mixture" and the fact of tetrachromatism. Figure 1 represents the Thomas Young color-triangle with the introduction of definite points (circles) for yellow and for white. Vision is made up of all possible blends (some thirty thousand in all) of five unitary sensations—one achromatic (white) and four chromatic, which are, in the order of their development, Yellow and Blue, Red and Green. (When Hering chose his red and green, since it was essential to his theory to make them complementary colors, he took a bluish red and a bluish green—what I shall write as R_b and G_b. These colors are indeed complementary—R and G *and* B are (in the right proportions) a "white-constitutive" combination (triad)—but it is only by a curious illusion that his colors can be thought of as red and green.[1] This illusion, however, imposed upon his readers by Hering, he has been tremendously successful in inducing in the minds of his followers for some seventy-five years.

But it is one of the very numerous misfortunes that beset the subject of color that the spectrum, which would have been much more easily understood if there had been a simple blue at the high-frequency end, in reality shows there a recrudescence of the red with which it begins. A diagram of the course of the three initial-process curves is given in Fig. 2.

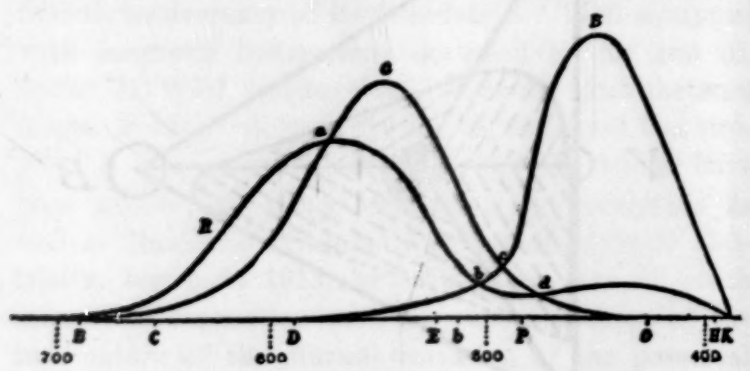

FIG. 2. R, G and B distribution curves. These are the curves of König and Dieterici, in their final corrected form. Abscissae, wave-lengths of the interference spectrum of the arc light; ordinates, arbitrary scale.

Diagrams have been laid down for the (four) distribution curves of the Hering colors also, but they are all purely the work of the imagination (*Am. Journal of Physiology*, **32**, 30, 1913). The Koenig-Helmholtz curves, on the other hand, are the product of an enormous amount of work in "matching the spectrum by mixtures of light-frequencies," carried out by Koenig in the Helmholtz laboratory. These curves have also been magnificently confirmed by their coincidence, respectively, with the two types of chroma-blindness, the deuteranopic (that of the vision of the human mid-periphery) and the protanopic (the color-vision of the bees); defective human vision (what every twentieth man you meet has got) is about equally divided between these two types.

On the other hand, we have much to be thankful for that, except for this second maximum of the red, the three curves are as simple as they are—they might have been so complicated as to be quite unravelable. It is also fortunate that they are only three in number, and not four even, in spite of the fact that the different chromatic sensations that they end in producing are four and that the light-sensations in all are five—white also is a color but an achromatic one. No reason is known for the second maximum of red, but of course no reason is known for the shape of any of the three resonance curves.

On the other hand, the physicist, who makes so much of violet, is capable of wholly overlooking the fact that there is another color in the spectrum (and in the world) which there is every reason for mentioning—it is in fact the most brilliant color of them all, *viz.*, yellow. It is true that all you need to put in in order to produce, by mixing, the complete spectrum is red and green and blue; but if you would only take the trouble to look at this spectrum which you have produced, you can not fail to see that while two of the dual chroma blends which you might expect[3] are indeed present, the third (what should be the red-greens) is conspicuous by its absence, and not only is that the case but something else—something entirely new, not in the least resembling a reddish green or a greenish red—has jumped in to take their place. It is exactly the same as if, on mixing in your test-tube a certain proportion of hydrogen and chlorine they should both of them absolutely vanish, and their place should be taken by a hydrochloric acid which has no trace of any of the properties of either of its constituents. Of its constituents, we say! Ever since the discovery of chemistry by Lavoisier magical events of this sort are no longer magical—we say at once, when properties perform this dance of disappearing and reappearing, that "a chemical reaction has taken place." Then why avoid employing the same term and making use of the same conception when (1) red and green vanish and have produced yellow, and (2) yellow and blue vanish and have produced white—especially since, if you look at the development of the color-sense, yellow is seen to be the color which red

[1] The real red and the real green, when mixed, give yellow, as every physicist knows.

See Apppendix on The Nature of the Color Sensations, in Helmholtz, Physiological Optics (English translation) II, 468.

[3] The blue-greens and the red-blues.

and green were developed out of, and white (at a still earlier time) the color which yellow and blue were developed out of? Does the great discovery of Lavoisier—the occurrence of the chemical reaction—exist for the color-physicist in vain?[4]

Violet is a popular but unscientific name for a slightly reddish blue, as any one can see by giving the matter a moment's attention. A child can perform this analysis. My little girl, when three years old, stopped on the street—her scientific curiosity aroused—when she saw for the first time a brilliant purple surface, and exclaimed "Bu!—wed!—wed!—bu!" This is proof positive—what the Eskimos have also furnished proof of—that purple really is at once blue and red or red and blue. And yet a physicist even at the present day (Frank Allen) can propose a theory in which violet (a red-blue) is a fundamental color—that is, a sensation which is assumed to have a single physiological correlate attached to it! And Professor Knight Dunlap has proposed a theory (*The Psychological Review* **22**, 99, 1915) which he seems, however, not to have insisted upon in later years, in which the elements assumed are mauve, peacock and yellow (in other words, red-blue, blue-green and green-red)! The fundamental principles which make such an assumption as this quite impossible have been admirably set forth by Professor G. E. Mueller. (*Zeitschrift. f. Psych. 10,* 2, 321, 1896.)

But color is a subject in which the physicist is very apt to engage in fallacies. So distinguished a scientist as Professor Millikan is capable, when speaking of color, of committing a plain "wrong conversion," as the logician has called it. He says (textbook on Physics, by Millikan and Gale) after having shown that white light can be separated up into all the colors of the spectrum, "we have shown that white light is composed of all the colors of the spectrum." But in fact white light is composed of red, green and blue; or—just as well—by the mixing of the most homogeneous obtainable yellow and blue light rays; it is not at all necessary to put in all the blue-greens, the green-yellows, etc., nor even yellow. Moreover, white can be seen *at every point of the spectrum* (with no mixing whatever) in these several (additional) cases:

B. The normal eye (*a*) in a faint light,
(*b*) in the extreme periphery of the retina,
(c) when a minute point is looked at,
C. The totally chroma-blind,
D. The lower animals (below the bees).

[4] See "Tetrachromatic Vision and the Genetic Theory of Color." SCIENCE, *55,* 555–560, 1922.

Until the physicist can be persuaded to give his attention to such facts as these, he will never be able to speak with intelligence on the subject of the color-sensations. But the case is not altogether hopeless. Professor Peddie has said in *Nature* (July 18, 1925) that the theory which I have proposed for holding together all these very complicated facts—the genetic theory of color—"may well turn out to be the real state of things"; and Professor Crew, in the new edition of his "General Physics" has used it as the *cadre* in which all these facts can best be understood. The physicist is recommended to read Professor Crew's exposition.

CHRISTINE LADD-FRANKLIN
COLUMBIA UNIVERSITY

ADDITIONAL RECORDS OF THE OCCURRENCE OF THE FRESH-WATER JELLY-FISH

THROUGH the kindness of the Bureau of Fisheries the following communication and specimens of this fresh-water medusa were brought to the attention of the National Museum:

July 30, 1927

The Commissioner,
U. S. Bureau of Fisheries,
Washington, D. C.

Dear Sir:

Inasmuch as the organism Craspedacusta is considered so rare according to Ward and Whipple in their "Fresh-Water Biology," I would like to take this opportunity to let you know that we have found our Slow Sand Filters swarming with the Medusa form of above, and specimens taken into laboratory are apparently thriving on the organisms in raw water. Our supply is fresh water taken from above Great Falls above tidal water possibilities and I would appreciate if you could tell me where their source might be.

This is the first time this organism has ever been noted here in our twenty-three years' operation.

Very truly yours,
(Signed) CARL J. LAUTER,
Chief Chemist

Mr. Lauter tells me the medusae he brought to the Bureau of Fisheries on July 30 were first noticed on July 28, and that they occurred at one time or another thereafter in practically every bed.

Each filter-bed is about 200 feet square and about four feet of water above the level of the sand. The beds are virtually in total darkness and there is very little circulation of air. The temperature of the water at this time of the year differs but little from that of the open storage reservoir from which it is drawn. At 8 A. M. on August 17 the temperature of the water at the surface in the filter was 74° F.

and in the open reservoir 75° F., August 18 at about 11 A. M. air temperature outside 71°, water in open reservoir 73° F., and in filter-bed 75° F. The water is slowly admitted to each bed through a main, discharging about 3 million gallons per day.

Bed No. 8, examined August 9, seemed crowded with medusae. When the door of the bed was opened, the jelly-fish hastened to the light from all directions. There were literally thousands in sight at one and the same time. Though still present in this bed on August 12 and 13, not a single one was noticed on August 14 even after vigorous churning of the water. In fact, none were noticed in more than half a dozen beds opened that day. Late the same afternoon a few were found in Bed No. 7, where on the morning of August 15 over a hundred were secured. A few days later, so far as known, the medusae had completely disappeared.

In their exceptional appearance and sudden disappearance these specimens ran true to form, but in this case at least attention must be called to the fact that during the period that the medusae were found in the filtration plant the water eight miles above this point was not being alum treated, though their sudden disappearance did about coincide with its resumption on August 19. Mr. Lauter assured me, however, that traces of alum are never found in water entering the beds. This would seem to indicate that the medusae had entered the filters with the inflowing river water, but as they were not noticed at any time in either of the two open storage reservoirs through which the water entering the system passes, the medusae may have originated coincidentally from "microhydras" within the filter-beds. However, scrapings of the side walls, the surface sand, and a plank walk extending from the entrance door down to the surface of the sand, of a freshly drained filter-bed in which medusae had been found, failed to reveal any trace of the hydroid generation. On the other hand, the well-known hydroid *Cordylophora lacustris* Allman was found abundant, thus adding another strictly fresh-water record to its occurrence in the United States.

A newspaper mention of this phenomenon resulted in a communication to the museum by Mr. J. W. Keys, of Washington, D. C., who reported seeing jelly-fish in two connected pot-holes on the Virginia shore of the Potomac near Great Falls. He first observed them on August 7, and again on the twenty-first, but by the time of his third visit to the place, about September 1, they had vanished.

Dr. H. B. Bigelow, of the Museum of Comparative Zoology, kindly determined the medusae as *Craspedacusta sowerbii* (Lankester). In North America the species has been found several times in the eastern United States and at one locality in the middle west.

The first fresh-water jelly-fish recorded from the United States was observed by Edward Potts,[1] who gave it the name of the hydroid from which he had seen it budded off, *Microhydra ryderi*. It appears to be a juvenile stage of *Craspedacusta sowerbii*, which name takes precedence by right of priority. The hydroid form had been taken from the rocky bed of a mill stream, Tacony Creek, near Philadelphia, and later also found prevalent along the Schuylkill River.

The year before Potts made his last report on this jelly-fish it appeared in a greenhouse aquarium at Shaw's Lily Pond, on the outskirts of Washington, D. C., as recorded by the late Prof. C. W. Hargitt.[2] These aquaria have not been in use for a number of years and there is no recollection by present generation of Shaws that they ever recurred since the original find.

On a number of different occasions, most of which were made public through these columns, Prof. Harrison Garman[3] has found *Craspedacusta* in great numbers in Benson Creek, Kentucky.

Meanwhile, Dr. R. E. Coker discovered some specimens in an artificial pond at Augusta, Georgia. These are mentioned in the only complete account of the development of the medusa since the studies made by Potts on the younger stages, by Prof. Fernandus Payne[4] under the name *Craspedacusta ryderi*. He had abundant material over a period of years from 1918 to 1924, from an artificial body of water, Boss Lake, near Elkhart, Indiana.

Since the foregoing was written, Mr. Henry S. Barton, of Owensboro, Kentucky, has presented the National Museum and the Bureau of Fisheries with a number of specimens of *C. sowerbii* he had taken in "Indian Lake," August 21. This body of water presumably is near Owensboro, and the latter is about 120 miles to the westward of Benson Creek where Dr. Garman found the first Kentucky specimens. Their transparency, short life and unsubstantial constitution, together with conditions under which they occur in nature render it difficult and often impossible for the casual observer to notice their presence in any body of water. Garman says "The best conditions, judging by the character of the three seasons when it has been found [in Benson Creek], are settled, clear days, when the water is low, free from silt, and there is little current in the creek," and it should be added, during August and September. It may be that the appearance of this jelly-fish is as sporadic

[1] *Amer. Nat.*, Vol. 31, 1897, p. 1032, and *Quart. Jour. Micros. Sci.*, N. S., Vol. 50, pt. 4, No. 200, 1906, pp. 623–633; also *Del. County Inst. Sci. Proc.*, Vol. III, no. 3, 1908, pp. 90–106.

[2] SCIENCE, Vol. XXVI, 1907, p. 638, and *Biol. Bull.*, Vol. XIV, 1908, pp. 304–318.

[3] SCIENCE, Vol. XLIV, 1916, p. 858; Vol. LVI, N. S., 1922, p. 644; Vol. LX, N. S., 1924, p. 477.

[4] *Jour. Morph.*, Vol. 38, no. 3, 1924, pp. 387–411.

and irregular as that of *Apus* in many parts of the world.

From the accumulated records one can not but be convinced that *Craspedacusta* and its alternative generation are much more common and widely distributed in the fresh waters of the eastern and eastern central United States, at least, than heretofore believed, and that continued and careful examination of particular bodies of water over a period of years will prove this to be the case.

WALDO L. SCHMITT
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THE MAGNETO-OPTICAL EFFECT AND THE ZODIACAL LIGHT

IN SCIENCE for October 21, 1927 (Vol. 56, page 376), Dr. Elihu Thomson publishes a new hypothesis to explain the zodiacal light. Some years ago he noticed that the particles of iron from the smoke of an arc were oriented by a magnetic field, so as to reflect light strongly in certain directions. He suggests that the zodiacal light may be due to particles of iron oriented by the earth's magnetic field.

The zodiacal light is a faint illumination seen in the west just after twilight, or in the east just before dawn. It is always centered on the ecliptic, or plane of the earth's orbit, being brightest just above the haze which nearly always dims anything seen near the horizon. The brighter portions of the zodiacal light are distinctly more brilliant than the milky way. Spectroscopic tests indicate that it is simply sunlight, and it is fifteen or twenty per cent. polarized, as would be expected after reflection.

The generally accepted hypothesis may be summed up in Moulton's words "It is universally agreed that the zodiacal light is due to a great swarm of small bodies, or particles, revolving around the sun near the plane of the earth's orbit. These small bodies are in reality planetesimals which have not been swept up by the planets, ..." The new Russell-Dugan-Stewart text on astronomy presents this hypothesis with the introductory statement "The observations make it almost certain that . . . ."

Although ordinarily not seen to extend more than ninety degrees from the sun, tests at Mt. Wilson have shown that some illumination extends over the entire sky. Keen eyes can, under the best conditions, discern a faint patch of light at the point on the ecliptic directly opposite the sun. This is known as the gegenschein. The swarm of small bodies must extend in appreciable numbers well beyond the earth's orbit. Particles opposite the sun would be seen at the "full" phase, like the full moon. The gegenschein is further explained by the fact that the combined attraction of the earth and sun tends to concentrate such particles in a sort of dynamic whirlpool about a point nearly a million miles outside the earth's orbit.

The fact that iron lines are conspicuous in the solar spectrum, and that iron is an important constituent of meteorites, suggests that iron particles may be numerous among those reflecting to us the zodiacal light, but the following observational evidence indicates that Dr. Thomson's effect is unimportant.

(1) The zodiacal light is most conspicuous just outside of twilight, perhaps 30 degrees to 40 degrees from the sun, and ordinarily fades into invisibility before 90 degrees is reached. The Thomson effect would produce the glow at 90° to 150° from the sun.

(2) The zodiacal light is always seen along the ecliptic, or plane of the earth's orbit. The orbits of all the major planets are nearly in this plane. The Thomson effect depends on the earth's magnetic field, and so, in general, would not follow the ecliptic.

(3) As the earth's shadow extends to more than three times the distance of the moon, the gegenschein, or glow at the point opposite the sun, must be produced by particles which are presumably too distant to be oriented by the earth's magnetic field. Particles as near as the moon would, in that direction, be within the shadow of the earth and, therefore, invisible.

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THE INDIGENOUS NATIVE POPULATION OF ALGERIA IN 1926[1]

IN a recent book[2] the indigenous native population of Algeria was studied in considerable detail, as the only example known to me of a human population which had virtually completed an entire logistic cycle of growth within the period of census taking. To the counts of this population made by the French between the years 1851 and 1921 inclusive, there was fitted, by least squares, the logistic curve

$$y = 2.238 + \frac{3.141}{1 + e^{1.2059 - 0.4232x}} \qquad \text{(i)}$$

with the results shown in Table 1 for the years 1881 to 1921 inclusive, during which period the observed figures may be regarded as substantially reliable.

There have now come to hand[3] the results of the 1926 census of Algeria. It appears that the indige-

[1] From the Institute for Biological Research of The Johns Hopkins University.

[2] Pearl, R. The Biology of Population Growth. New York (Alfred A. Knopf), 1925. Pp. xiv + 260.

[3] *Jour. Soc. Stat. de Paris*, November, 1927, p. 291.

TABLE 1

OBSERVED INDIGENOUS NATIVE POPULATION OF ALGERIA AND FITTED LOGISTIC CURVE

Year	Observed populations	Calculated populations from logistic curve	Percentage deviations of calculated from observed values
1881	2,842,497	2,962,000	+4.05
1886	3,287,217	3,224,000	—1.95
1891	3,577,063	3,529,000	—1.36
1896	3,781,098	3,859,000	+2.02
1901	4,098,355	4,184,000	+2.06
1906	4,477,788	4,478,000	± 0
1911	4,740,526	4,723,000	—0.38
1921	4,924,938	5,060,000	+2.67

nous native population in that year was in total, 5,192,426.

The logistic curve shown in equation (i) was calculated on the basis of the data up to and including 1921. Extrapolating that curve it gives for the expected or probable magnitude of the indigenous native population in 1926 the value 5,162,000. This underestimates the population actually observed in 1926 by 30,426. This is a percentage error of only −0.59 per cent. To miss by just over one half a man in each hundred counted is certainly not a serious discrepancy. Probably few demographic experts would care to assert that the error made in counting a population, however highly civilized, is less than six tenths of one per cent.

The chief point of general significance in this result is that it makes still more valid the case of the native population of Algeria as an example of a human population following the logistic curve in its growth.

In closing I should like again to emphasize, as has been done repeatedly in what I have written on population growth, that the data in hand permit no prediction as to whether the native population of Algeria (or any other population) will in the future continue to follow its past logistic curve in its growth. All that the logistic theory of population growth is capable of saying on the point is that this result is to be expected only if the same forces, economic, social, geographical and possibly other, which have influenced the birth and death rates during the past history of the population continue to operate unaltered in the future, but not otherwise. If any or all of these factors undergo any considerable alteration in the future the course of population growth may be expected to depart from the particular logistic curve which it has followed hitherto.

RAYMOND PEARL

SCIENTIFIC BOOKS

Recent Advances in Haematology. A. PINEY, M.D., P. Blakiston's Son & Co., Philadelphia, Pa, 1927.

THE author of this welcome and timely book, dealing largely with clinical hematology, very properly bases his interpretations of blood pathology on the data of normal blood development and those of the normal histology of the several hemal formative organs, yolk sac, liver, spleen, lymph nodes and bone marrow. This is an approach to an understanding of the leucemias and primary anemias that seems to offer the most promising results. In future a still more adequate attack will be made by way of the evolutionary history of blood and the hemopoietic tissues. Information already at hand emphasizes the vastly greater genetic significance of the lymphocyte than is now generally accorded this hemal outcast. For a work of this sort, properly a fairly inclusive digest, the discussions and interpretations seem dominated unduly by a personal working hypothesis, namely, the assumption of the exclusively entodermal origin of the earliest embryonic red blood cells and the occasional anomalous persistence of this entodermal blood primordium in postnatal life.

The book includes 249 pages of text, subdivided into 14 chapters. Chapter I gives an account of the reticulo-endothelial system. In Chapter II the blood forming function of this system is discussed. Chapter III on "Leukaemia," and Chapter IV on pernicious anaemia, constitute in our opinion the most interesting portions of the book. Chapters V and VI deal with leukaemoid blood pictures and reactions, Chapter VII with reticulo-endotheliosis, Chapter XI with Gaucher's disease and Chapter XII with Banti's disease. There is an important appendix of 11 pages on hematological technique and a selected bibliography of 73 titles, with author's comments. In addition the book contains four plates of very excellent colored illustrations, 23 in number, and 18 text figures.

As regards the colored illustrations the reviewer, while admitting their artistic beauty and detailed accuracy, feels compelled to point out certain disconcerting omissions and seemingly forced interpretations. In the first place, one feels greatly handicapped in estimating the value of these illustrations as supporting the text by reason of the lack of any designation of either absolute or relative magnification. This is all the more serious in view of the great significance ascribed by Piney to his so-called megaloblast. In the next place one is not convinced on the basis of the illustrations that the so-called promonocyte is more closely related to the myeloblast

than to the lymphoblast. Then, too, the lack of illustrations of transition stages between the large lymphoblast and the small lymphocyte, and especially the absence of any illustrations of a large lymphocyte, seems unfortunate. Furthermore, the eleven figures grouped under the name "megaloblast" are so very different in nuclear configuration and cytoplasmic staining reaction, that they can not with any propriety or accuracy be designated by a common term. If the relatively larger size of these pro-erythroblasts is to be emphasized, surely Figures 9 and 10 are more properly called macro-normoblasts, a term improperly applied to Figures 12 and 14. These illustrations by no means support the claim that the alleged entodermal pro-erythroblasts differ specifically from the mesodermal pro-erythroblasts by the absence of a "cart-wheel" arrangement of the nuclear chromatin (Compare Figures 7 and 15).

In Chapter III, Piney stresses the importance of regarding leucemias as diseases of the hemopoietic tissues, rather than as "blood diseases." He accepts Orth's suggestion to designate all conditions of hemopoietic excess, usually accompanied by alterations in the circulating blood, as *haemoblastosis*, in essence a neoplastic condition. Such hyperplasias may be restricted to the leucocytopoietic tissues or to the erythrocytopoietic tissues. The former condition may be designated *leucosis* ("leukemia"), the latter *erythrosis*. When the leucosis affects only the myeloid tissue, the condition becomes a *myelosis;* restricted to the lymphoid tissue, it constitutes a *lymphadenosis*. Either condition may be acute or chronic, leucemic or aleucemic. The excessive number of red corpuscles in the circulation in the condition of erythrosis is termed *erythraemia* (polycythemia). A concomitant hyperplasia of both the erythrocytopoietic and leucocytopoietic tissue, Piney terms *erythro-leucosis,* or synonymously as *panmyelosis*. Hyperplasias of the ancestral reticulo-endothelium may also occur as variations of hemoblastosis. Such conditions are designated *reticulo-endotheliosis,* the leucemic variety possibly constituting monocytic leucemia, the aleucemic possibly Hodgkin's disease.

The central and guiding concept in Piney's interpretation of hemoblastosis relates to the so-called "megaloblasts." In current hematological literature the term "megaloblast" is definitely restricted to designate the earliest transition stage between the ancestral hemoblast and the hemoglobiniferous normoblast. This cell is characterized specifically by the presence of a minute amount of hemoglobin in its otherwise basophilic cytoplasm, imposing a slight acidophilic staining reaction in polychrome stains, *e.g.,* Giemsa. In addition, it has a slightly larger size than the later generations of red cells (normoblasts and erythroblasts) and its nucleus generally lacks the nucleoli of the hemoblasts, and the basichromatin approaches the relatively coarse reticular condition of the normoblast. Piney, quite arbitrarily it would seem, applies the term "megaloblast" to a large cell of the hemoglobiniferous series whatever its stage of development. He uses the term in its strict etymological sense to denote a large maturing red cell, ancestor of an anucleate "megalocyte." Very much more important, however, is his conception of the *origin* of the "megaloblast"; he derives it exclusively from the *entoderm*. The megaloblast of Piney is therefore an entodermal element, and occurs normally only in the embryo. He says, "The embryo is thus supplied, for a short time, with two varieties of blood; one derived from the entoderm, and composed purely of hemoglobiniferous cells; and the other of mesenchymal origin, and consisting of both red and white cells" (p. 19). This supplies the basis for Piney's interpretation of various leucoses in which megaloblasts appear in the blood. It constitutes his chief contribution to the question of the etiology of pernicious anemia. The appearance of megaloblasts in postnatal life he regards as always indicative of the persistence of some remnant of entodermal blood primordium. He assumes further, that if this hemic primordium atrophies only incompletely in post-embryonic life, there occurs a concomitant defective development of the mesodermal myeloid tissues. Pernicious anemia is interpreted as a condition in which, following a hereditary defect inherent in a hepatic persistence of entodermal hemocytopoietic tissue, there occurs correlatively a poor quality of bone marrow. Naegeli had already pointed out that the presence of megaloblasts (mesenchymal ancestors of hemoglobiniferous megalocytes) in the blood is pathognomonic of pernicious anemia. But Piney interprets this datum in a unique sense; he ascribes to these cells the significance of specific entodermal derivatives.

Investigations on the origin of the initial red blood cells in the yolk sac of mammals and other vertebrates during the past twenty years give no support to the idea of an entodermal origin of these cells. From beginning to end, blood arises only from mesenchyme, the reticulo-endothelial system of various myeloid and lymphoid organs. An alleged exception is described in the papers by Havet[1] and Aron,[2] who claim that

[1] Havet, J., 1926. L'origine des cellules du sang. *Jour. Anat.* Vol. 60, pp. 231–258.

[2] Aron, M. Quelques observations novelles a' propos de l'origine du sang dans le foie embryonnaire des mammiferes. Arch. d'anat. d'Hist. et d'Embryol. T. 4, pp. 1–26.

in young mammalian embryos (rabbit, sheep, pig, guinea pig, and human) erythrocytes develop directly from hepatic parenchymal cells. These recently recorded results, however, lack confirmation, and the supporting illustrations admit of an alternative interpretation.

It is well known that in pernicious anemia generally the red corpuscles are of larger average size, thus determining a color index above unity, and that megaloblasts (initial stages in red cell formation) occur; but the relatively larger size of both may be quite as well, and much more likely, the result of an absence of normal proliferative activity of these proerythroblasts, as of persistent entodermal ancestors. The familial incidence of pernicious anemia may equally plausibly be explainable on the basis of a hereditary susceptibility to factors that affect the bone marrow, and other possible erythrocytopoietic foci, in such a way as to produce a condition characterized by relatively low proliferative activity among the ancestral cells, resulting in the appearance of many relatively large red cells, both mature and immature.

Another interpretative conclusion, in conflict with practically all recent work, relates to the restricted ancestry of the monocytes. According to Piney, monocytes are derived from the reticulo-endothelial system exclusively through the myeloblasts, a monocyte being "as much a myeloid cell as is any other granular leukocyte."

Though emphasizing the alleged distinctive character and apparent independence of the lymphatic and myeloid tissues in many respects, Piney is forced to admit certain obvious interrelationships as indicated in certain infections where lymphocytosis coexists with a neutrophilia, following a leucopenia during the height of the infective process. A probable explanation seems to be at hand in the repeated demonstrations that lymphocytes may develop into granulocytes. At the height of the demand for neutrophils the lymphocytes may be very rapidly converted, effecting a resulting lymphocytopenia, which may be later overcorrected through an attempt at compensatory readjustment of normal numerical relationships. Similarly the anemia almost invariably accompanying leucemia might be interpreted in terms of the limited availability of the common ancestor (the lymphoid hemoblast) for erythrocytes, granulocytes and monocytes. When the specific stimuli are such as to demand an excess of one of the derivatives, the other possible differentiation products may be reciprocally, at least temporarily, reduced in numerical proportion. This differs from Piney's explanation that since (as he claims) erythrocytes arise o intravascularly, and leucocytes extravascularly, s cific morbid stimuli may reach one surface of t common blood cell primordium without affecting t opposite surface.

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DOES THE AMOUNT OF FOOD CONSUMED INFLUENCE THE GROWTH OF AN ANIMAL?

THE question to which this discussion is addressed might well be considered an impertinent one to ra in a scientific journal were it not for the fact that number of research laboratories in this and oth countries appear to be attacking many importa problems in nutrition by methods involving the ta assumption that *the composition of the diet alo* determines the changes in body weight secured experimental animals. When stated in such pla terms as these, the situation, if it actually exis would appear to be sufficiently serious to justi general consideration and discussion, to the purpo that the time and energy being devoted to nutritio problems should yield the greatest return in unequ ocal experimental evidence.

Obviously, the point of first importance is to dete mine whether the situation characterized above act ally exists. This characterization may be illustrat in an abstract way as follows. It is desired to dete mine whether a given food material is deficient in certain dietary essential A. Accordingly, two ratio are made up, including the food material in questi supplemental with adequate percentages of all know dietary essentials except A. In one ration, A is i cluded in place of an equal percentage of a dieta diluent such as starch, while in the other ration t food itself serves as the sole source of A. Now, is the general plan to feed ration No. 1 to one grou of animals, and ration No. 2 to another, the food each case being offered *ad libitum*. The changes weight of the animals are then followed by periodic weighings. In some cases, records of food consum may be kept and, in fewer cases, such records m be reported, but in the great preponderance of case no *control* of food intake is imposed, and the weig curves are interpreted with reference only to the co position of the rations.

Is not this type of interpretation tantamount assuming that the amount of food consumed has influence on growth? The assumption itself is ob viously untenable, and the interpretation can be de fended only on the very tenuous supposition that

more adequate of two rations will *always* be consumed in the larger amount and that, therefore, a greater consumption of one of the two comparable rations is, itself, *prima facie* evidence of its nutritive superiority over the other. While it is true that there is a marked tendency, frequently referred to in the literature, for experimental animals to eat sparingly of markedly deficient diets,[1] to assume that this is the only factor of importance operating in the determination of the daily consumption of food is to deny the influence of flavor, odor, and texture of the diet, and to endow the appetite of the animal with an infallibility impossible to explain on physiological grounds or to believe on empirical grounds.

Returning to the hypothetical illustration, if ration No. 1 has induced better growth than ration No. 2, there are two possible explanations, either (a) it is actually superior in its nutritive balance, so that if consumed in amounts no greater than ration No. 1, it would still induce better growth, or (b) it has been consumed in so much larger amounts than ration No. 2 that better growth has resulted from this fact alone, with no reference to the difference in composition. Current practice neglects the latter possibility entirely, apparently because no obvious reason exists for supposing that ration No. 1 is more palatable than ration No. 2; hence, if it has been consumed in larger amounts it must be because it is more nearly adequate in nutritive value. But this is devious reasoning. It is true in many cases it may lead to a highly probable conclusion; nevertheless, in no case can an interpretation based upon such reasoning be awarded the finality of a demonstration. Surely it is the purpose of experimentation to demonstrate something whenever possible, rather than to set up a certain probability of its truth, and in this type of work a demonstration can be secured only by controlling the food consumption of the experimental animals in such a way that the intake of food by comparable groups is the same, either absolutely or in proportion to their requirements.

The many different problems in which this question of experimental technic is involved can only be appreciated by specific illustrations. The significance of food intakes is involved in every step of the method for the "biological analysis" of foods introduced into rather general use about twelve years ago, and the neglect of dietary control with reference to the amount of food consumed is a proper obstacle to the acceptance *in toto* of the deductions regarding the dietary deficiencies of the large number of foods investigated. The method has contributed valuable viewpoints to the science of nutrition and has undoubtedly furnished an essentially accurate bird's-eye view of the situation with reference to relative food values. Nevertheless, the details of the results with reference to any particular food can not be considered as established facts until confirmed by more refined methods. As a pioneer method, it has served its purpose well, but pioneer methods are of use only in pointing the way to profitable investigation by providing working hypotheses; it is unfortunately true that several laboratories are still using the method in a routine way in attacking specific problems.

A recent contribution from an agricultural experiment station, involving several years' work upon a large number of animals and rations, attempts a scientific analysis of the factors concerned in the production of rickets (posterior paralysis) in swine with no reference at all to the food records secured, though these records were extremely variable among the lots of animals compared. If the efficiency of a number of rations in promoting growth or protecting against disease varies in close correlation with the amounts of them consumed by the experimental animals, it is but natural to suppose that the biological reactions observed may have been determined entirely by the intake of food regardless of its composition. If one of two comparable rations has induced a more rapid growth than the other, as well as a greater consumption of food, there must always be a doubt as to the growth that would have resulted from the other ration if it had been consumed in as large amounts as the first.

Fortunately, the ambiguity inherent in the experimental results obtained from the "biological analysis" of a food by means of *ad libitum* feeding experiments is becoming increasingly evident to investigators in nutrition. The prevailing tendency in determining the nutritive value of a food material is to consider each individual nutrient as presenting a problem in itself, to be investigated by a method found to be most effective for that particular nutrient. As a result, there are available at the present time reasonably accurate methods for the determination of the protein values of foods and of the relative concentrations of foods in vitamins. These methods differ essentially among themselves in the experimental conditions imposed, the kinds of animals used, and their preliminary preparation. In the most accurate methods for the quantitative study of the distribution of vitamins, the necessity of securing definite intakes of the food material under investigation is fully recognized, although the intake of the basal ration used in providing a suffi-

[1] The conclusion has also been drawn that rats eat in accordance with their energy requirements rather than in accordance with the balance of nutrients in the ration. Furthermore, many instances have been reported in the literature in which inadequate diets are consumed for a considerable time in adequate amounts, and vice versa.

cient source of energy and in supplementing the food in all essential dietary factors except the one under investigation, is not controlled. It may be questioned whether control of the intake of basal ration is not also advisable, since it will undoubtedly vary with different animals, and will be inversely correlated with the intake of the food material being studied. For the same intake of the food under examination, a variable intake of basal ration presumably would affect the rate of growth secured.

Much work has been done upon the existence of vitamins specifically concerned with reproduction and with lactation. Feeding experiments with uncontrolled food consumption have been used throughout this work, and several of the conclusions drawn from such experiments seem unwarranted because of the failure to realize that the biological performance of an animal may be distinctly different on different intakes of food, particularly if the rations fed are not absolutely deficient in any essential food factor. The confusion prevailing in this field at the present time and the slow progress being made may be considered as an inevitable result of improperly controlled experimental procedures.

The question of the significance of arginine and histidine in nutrition has occupied the attention of a number of investigators, in this country and in England, during the last ten years. While it is the consensus of opinion that the indispensability of histidine is well established, the evidence is conflicting with reference to arginine. Again the trouble appears to be related to the methods of experimentation, *i.e.*, feeding experiments on rats in which the food intake is uncontrolled. One laboratory reports that the addition of either arginine or histidine to an amino acid mixture deficient in both renders it capable of supporting growth, a result indicating an interchangeablility of these two amino acids in metabolism. Another laboratory has reported success in this experiment with histidine only, repeated attempts to supplement with arginine resulting invariably in failure to secure growth, though long-continued maintenance of weight was occasionally observed. This laboratory most emphatically denies the interchangeability of arginine and histidine on the basis of its negative results. Other laboratories have reported favorable effects of arginine additions to amino acid mixtures deficient in both arginine and histidine, though only maintenance of weight rather than growth resulted. In those experiments in which food intakes are reported, it is a significant observation that where failure of growth and of maintenance resulted on the arginine rations, the food intakes were so low that it is a fair suspicion that they were inadequate for the maintenance of weight. In fact, the results of this series of experiments suggest that success in obtaining growth on the arginine rations was in proportion to the success in inducing the animals to consume them.

It is perhaps a sound criterion that a ration can not be adjudged incomplete or inadequately balanced, until nutritional failure results *when it is consumed in adequate amounts,* or unless it induces distinctly less favorable results in experimental animals than a ration known to be complete, *when they are consumed in equal amounts.*[2] Under the circumstances, therefore, more significance would appear to attach to the favorable results obtained by arginine additions than to the unfavorable results. It is undoubtedly desirable that the interchangeability of arginine and histidine in metabolism be confirmed if possible, preferably by some other method more amenable to interpretation; nevertheless, it is a fair conclusion that the negative results reported do not disprove the possibility of an interchangeable relation.

A natural extension of such inadequately controlled feeding experiments to the solution of problems of intermediary metabolism has been in evidence during the last few years. The question whether taurine can replace cystine in metabolism has been studied in four laboratories by feeding experiments with small animals. In one laboratory the results obtained were taken to indicate the possibility of such a substitution; in two laboratories the non-committal conclusion was drawn that no evidence of such a possibility was obtained; while in one laboratory the negative evidence secured was the basis of the conclusion that taurine is "totally incapable" of replacing cystine in the diet for purposes of growth. However, the lack of control of food consumption in all these experiments in assuring comparable food intakes among otherwise comparable groups, renders a definite interpretation of them difficult, if not impossible.

Similarly, the results of experiments involving rations containing, in place of histidine, imidazole derivatives and other compounds with which it might be related biochemically, have been interpreted with reference to the possibility or otherwise of certain metabolic reactions involving this amino acid. No criticism can be made of the most obvious interpretation of such experiments when continued growth is observed; but when failure of growth results, interpretation seems impossible, although it is commonly supposed to demonstrate that the ration used is inadequate. This, however, appears to represent an

[2] As proof that this is not an impossible or impracticable requirement, the demonstration that non-leucine can not replace lysine in metabolism may be cited (Lewis and Root, J. Biol. Chem., 1920, xliii, 79).

exaggeration of the importance of negative experimental results.

Negative experimental results may have two meanings: (1) They may demonstrate definitely that something is not true, and, if this outcome is quite unexpected in view of contemporaneous theories and conceptions, the results may be of great significance. On the other hand, (2) they may represent simply unsuccessful attempts to demonstrate something, due to the use of inadequate experimental methods or to the selection of unsuitable experimental conditions, in which case they are of no considerable importance. It would appear that the type of negative experimental result obtained with inadequately controlled feeding experiments should be classified under (2), since it has not been definitely proven by proper control experiments that the failure of growth or maintenance can *only* be due to the inadequate composition of the ration.

As illustrating the ultimate result of a line of reasoning that is so frequently implied and pursued in the interpretation of incompletely controlled feeding experiments, another recent investigation concerned with histidine synthesis in the animal body may be cited. In this study evidence was obtained of the successful substitution of histidine by imidazole lactic acid and also by imidazole pyruvic acid; and a distinctly favorable effect on body weight of the addition of imidazole acrylic acid to histidine-poor rations was also observed. From the rates of growth secured on the different rations, conclusions are deduced concerning the intermediary metabolites of histidine, the reversibility of the reactions involved, and even the relative speeds of such reactions. These interpretations fail to consider the great differences observed in the consumption of the different experimental rations, which have been averaged and summarized in the following table:

No. of periods averaged	Rations	Aver. body weight of rats gms.	Aver. daily food intake gms.	Aver. daily gain in weight gms.
17	Basal, no histidine	99	2.3	−0.86
6	Basal, plus histidine	107	7.2	+1.67
4	Basal plus imid. lactic acid	98	5.9	+1.36
4	Basal plus imid. pyruvic acid	81	3.8	+0.45
6	Basal, plus imid. acrylic acid	112	3.2	−0.10
3	Basal plus imidazole	102	3.4	−0.25

It is evident that the changes in weight, although obtained in prompt response to the changes in ration, are closely correlated with the amounts of food consumed, and hence, in the absence of any evidence to the contrary, may be the direct result of the variable food intake. The experiments can not be said to demonstrate that the basal ration was inadequate, since the daily consumption of 2.3 gms. of food, no matter how well-balanced it may be, could not maintain the weight of a 100 gm. rat. The responses to the various additions to the basal diet may indicate: either (1) that the basal ration is in fact adequate and is capable of supporting growth when consumed in adequate amounts; or (2) that the basal ration is inadequate but that all of the imidazole derivatives added to it are equally effective substitutes for histidine, the variable growth secured depending primarily upon the amount of food consumed: or, finally (3) that the basal ration is inadequate and that the various additions to it are effective in replacing histidine in metabolism in proportion to the amount of growth secured, the variable food intakes being a purely incidental manifestation of the infallibility of the animal appetite in consuming food in proportion to its completeness in meeting the body's requirements. The authors of this report subscribe to the third interpretation, without, however, considering or refuting the other two.

These illustrations of published investigations involving feeding experiments on animals may be taken as proving that biological investigations are frequently based upon the implicit assumption that the amount of food an animal consumes has no effect upon growth and hence is not a legitimate part of the experimental evidence and, therefore, may be disregarded in the interpretation of results; or upon the equally erroneous assumption that the amount of food an animal consumes is determined solely by its value in nutrition. An experimental animal is considered as a sort of biological reagent of marvelous accuracy and varied uses, capable of giving as significant a response in body weight change to a change in ration, as the color response of a chemical indicator to a change in hydrogen ion concentration around the point of neutrality. Unfortunately this conception of the infallibility of experimental animals can not go unchallenged, and the methods of experimentation blindly involving this conception are in need of revision. They can not be considered to be properly controlled except when the rations whose nutritive effect it is desired to compare are fed in equal amounts to comparable animals. Even when the amounts thus fed are inadequate, due to the refusal of the experimental animals to consume readily one or both of the rations, it is reasonable to expect that the inferior ration will ultimately induce a greater decline in

weight than the other, or that it will lead to total nutritive collapse sooner. Admittedly experimentation under these conditions is not wholly satisfactory, but investigators should reconcile themselves to the fact that it is difficult to demonstrate the inadequacy of a given ration in any essential dietary factor when the experimental animal will not readily partake of it. Probably in many situations of this character the use of growth experiments is contraindicated. The success of any biological investigation is undoubtedly endangered when the experimental animal will not cooperate to a certain minimum extent.

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SPECIAL ARTICLES

OVARIAN SECRETION AND TUMOR INCIDENCE

FOR several years an attempt has been made to build up, by selective inbreeding, lines of mice which should have a very high incidence of mammary cancer. This effort has been quite successful, and it has been possible to establish two lines in an inbred dilute brown stock,[1] which produce very nearly 100 per cent. cancerous females. Among 183 breeding females of this dilute brown stock, taken in linear order from our ledger, 122 were tumorous. Of the remaining sixty-one, many died before reaching tumor age.

Under normal breeding conditions the neoplasms appear in the vicinity of the mammae of the females between the ages of four and fourteen months. The tumors usually appear, however, between the beginning of the seventh and the end of the eleventh months, the mode being at nine months.

It has been known for some time that the internal secretions of the ovaries play an important part in the physiological condition of females during and after the gestation period. That the influence of these hormones has also a direct effect upon the ability of mice to combat the growth of neoplasms has been demonstrated by Dr. L. C. Strong[2] (1922) in his work upon transplanted tumors. Dr. Leo Loeb[3] has also published (1915) a brief note on the effects of castration and enforced non-breeding on tumor incidences. More recently (1927) Dr. Carl F. Cori[4] has published a very interesting paper on the results of castration and ovarian transplantation in mice.

[1] This stock has been developed from a single pair by Dr. C. C. Little, and has been inbred, for the most part, by brother to sister matings since 1909.

[2] Strong, L. C., *Jour. Expt. Zool.*, 36: 1, 1922.

[3] Loeb, L., SCIENCE, Vol. XLII, No. 1095, Dec. 24, 1915.

[4] Cori, Carl F., *Jour. Expt. Med.*, Vol. XIV, No. 6, June 1, 1927, pp. 983–991.

I. What is the effect of enforced non-breeding upon cancer incidence in female mice?

That either or both of two factors: (a) the stimulating effect of lactation and pregnancy, and (b) the effect of sex hormones, may be involved in the appearance of cancer in the stock under observation, is demonstrated by the fact that when 207 virgin females of the dilute brown stock were separated from the males before sexual maturity and allowed to grow old under exactly the same conditions as the stock mice, which in many cases were siblings of the virgin females, but twenty tumors have appeared among them, although the youngest of these animals is fifteen and a half months old. The earliest age at which cancer appeared was ten months, the average 14.7 months, and the oldest seventeen months, as contrasted with four months, nine months and fourteen months for the breeding females (see Table I, lines 1 and 2).

TABLE I

AGE IN MONTHS

	Youngest	Average	Oldest
Breeding females	4	9	14
Non-breeding females	10	14.7	17
Castrated females	9	15.6	18.8
Castrated males with ovarian implants	8	11	13

From this we may infer that enforced non-breeding delays very markedly the age of tumor appearance and may even inhibit entirely the development of cancer in mice, which would probably have had a high incidence of tumor appearance had they lived a normal sexual life.

II. Will the female mouse grow a tumor when completely castrated?

The ages at which tumors occur in the normal breeding females indicate that the appearance of the neoplasms is closely correlated with the normal[5] activity of the ovary and ovarian hormones. One possibility is that cessation of ovarian action following a period of activity is the chief stimulating factor in producing mammary cancer. If, then, females in which the ovary has functioned at a low rate for a time are completely castrated, it might be expected that these animals will develop tumors at an age which is actually *younger* than that at which normal breeding females develop cancer. With this in mind, 210 females were spayed and allowed to grow old under the same laboratory conditions as the stock animals. To date twenty-one of these females have developed

[5] Normal activity of the ovary is here taken to mean that of a breeding female rather than a non-breeding animal.

mors. However, the ages at which these animals velop neoplasms is strikingly higher than that at ich the normal breeding animals develop cancer. ee Table I.)

It appears from these figures that the absence of rmone activity has a retarding effect on neoplasmic velopment, and may even inhibit tumorous growths, ce practically all of the normal breeding females velop tumors if they live to 14.9 months of age, ile in the castrated females only twenty in 210 have veloped tumor, although they have all reached an e equal or greater than that at which the oldest eeding female developed neoplasms.

The complete absence of ovarian secretion has much e same effect on cancer incidence as does forced non-eeding.

It appears from this that the secretions of the aries under ordinary non-breeding conditions are t primarily the ones which stimulate tumor, but ther that it is commonly those conditions of hor-one secretion in anticipation of the feeding of the mbryo and young.

III. Do testicular hormones inhibit the growth of ammary tumors?

Since mammary cancer does not occur among the ales of this race of mice, we might expect that pos-bly the testicular hormones inhibit these neoplasmic rowths. If this is the case, the removal of the testes ould remove the inhibitor and the operated individ-als would be likely to develop tumor. In order to st this theory, 241 males of this race of mice were strated at about four weeks of age and allowed to row old under the same laboratory conditions as the tock animals.

The youngest of these animals lived to be fifteen nonths old and the oldest twenty-two months of age ithout developing a single tumor. The relief from nhibition caused by castration at four to five weeks f age is, therefore, not sufficient to allow the growth f mammary tumor. There is a possibility that the estes of these mice had begun to secrete in sufficient mounts to protect these mice against tumor after astration. Possibly, had they been castrated at an arlier age, different results might have been obtained. his, however, is very doubtful.

IV. Is it possible to grow mammary tumors in cas-rated males by transplanting ovarian tissue?

If it is the ovarian hormones which are causing the rowth of tumors, ovarian tissue transplanted to cas-rated males encourages tumor development. With his in mind, 210 males were castrated and a whole ovary implanted subcutaneously in the abdominal egion. The animals were then allowed to grow old. At the time of writing, when the youngest of these animals is ten months of age, *four have developed mammary tumors*—a thing never seen in the thousands of normal male mice of this inbred stock.

It would seem that the ages of cancer appearance in these animals should approach the curve of the virgin females, although the numbers are very small.

Discussion

These results are interesting in that they correspond very closely with those reported by Dr. Carl F. Cori (1927). Our data, however, differ in several ways from his. Whereas he castrated his females at 15–22 days of age, we castrated ours at 28–35 days of age. Tumor was completely inhibited in his mice, while it was only partially inhibited in ours. This somewhat supports his conclusion that spontaneous cancer in the mouse is due to the lack of ovarian hormones after having had the use of it for a time.

Dr. Cori reports that in his castrated males, to which he transplanted two whole ovaries, no tumors appeared. Our experiment differed from his in that we transplanted but one ovary and obtained four males with mammary tumor from 210 animals treated in this manner. It is of interest to note that pathological diagnosis shows these tumors to be of the same type as those developed by the females in this strain of mice, namely, adenocarcinoma.

It is well known that in order to make successful transplantations of tissue, the animals involved must be very closely related. Possibly Dr. Cori's failure to feminize males was due to the fact that his stock was not sufficiently inbred, and the ovarian implant therefore degenerated.

Conclusions

(1) Non-breeding reduces tumor incidence in mice and delays the time of tumor appearance (207 mice used).

(2) Two hundred and ten female mice castrated at 28–35 days behave much the same as non-breeding females.

(3) Two hundred and forty-one males castrated at 28–35 days did not develop tumor, thus resembling non-castrated males.

(4) Spontaneous tumors, never obtained in thousands of normal males of the stock used, may develop in castrated males which have received subcutaneous transplants of ovarian tissue (210 operated—four tumors).

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THE CHROMOSOMES OF THE RAT

An attempt to use the chromosomes of the rat as confirmatory evidence in certain phases of work on